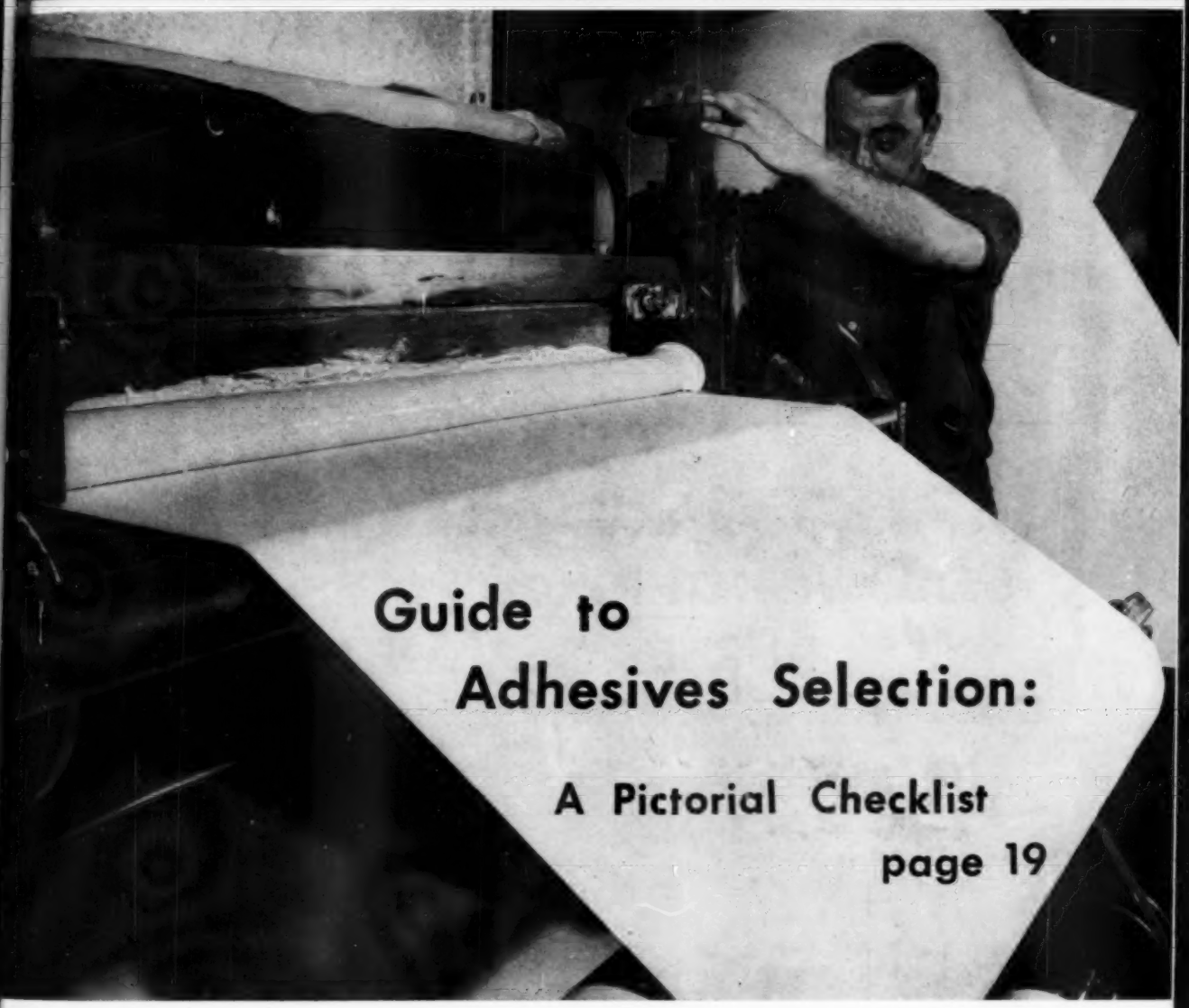
MARCH, 1959

ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING



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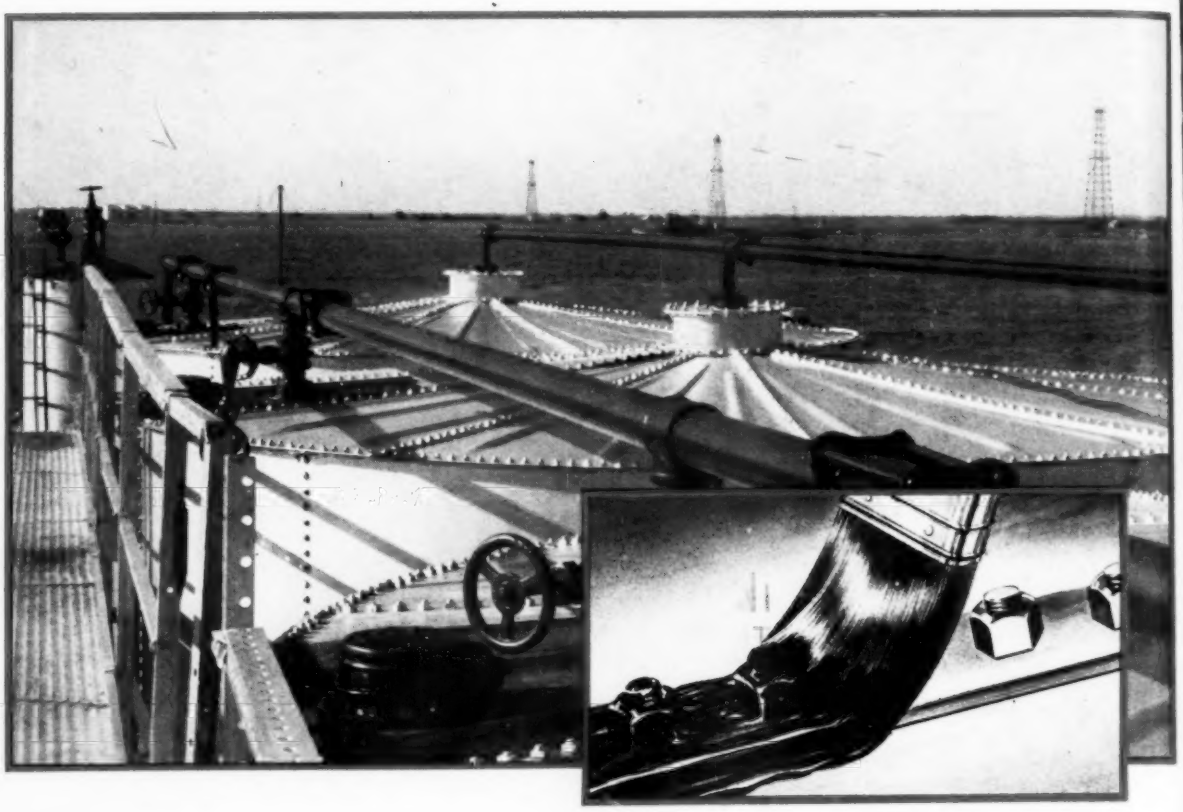

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ADHESIVES AGE

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A close-up view of the application of an adhesive by the knife coating method. The production line efficiency of an adhesive is often related to the application system chosen. The photo is used by courtesy of Rubber & Asbestos Corp.

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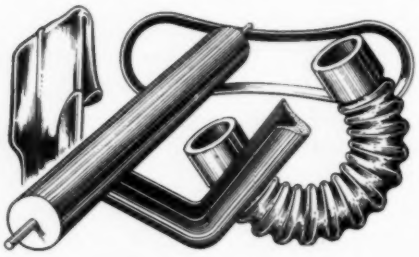

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EDITORIAL

A Specific Need for Specifics

The article "Guide to Adhesives Selection" which appears in this issue attempts to simplify the matter of selecting the proper adhesive for the job at hand through a checklist of end-use requirements. One of the points stressed in this article has to do with specification of what is to be bonded to what, and under what conditions.

One of the battles the adhesives industry fights daily has to do with the education of the lay public to the fact that there are different types of adhesives for different jobs. Oddly enough, many industrial consumers also seem to feel that "glue is glue" and should, by their own definition, do the job at hand.

When the results obtained under this method of adhesives selection are not what were required, the industrial consumer vents his wrath on the entire adhesives field. He may even, perish the thought, turn to nuts and bolts.

The time has come, it seems to us, for a new educational program aimed at industrial consumers. As a doctor cannot recommend an adequate prescription without a thorough examination, so an adhesives manufacturer cannot furnish a proper adhesive without a thorough knowledge of which materials are going to be bonded.

The adhesives manufacturer must also know what service requirements are involved. He must also know what equipment the consumer has for handling the adhesive. Some adhesives which are designed for glue gun application, may not be worked with so easily when applied with a trowel or brush.

What we are saying here, of course, is that this matter of adhesives selection must not be left to chance. There is a science involved. Adhesives, in many instances, are test tube products, tailor-made for specific application. The industrial consumer, with precise requirements, must arm the manufacturer with all the information he has available. Only in this way can the manufacturer perform his function. Only in this way can the consumer receive complete satisfaction.

This type of cooperation between manufacturer and consumer is a two-way street and it is a street we all must travel. Haphazard specifications lead to haphazard products. The image which the adhesives industry must create in the eye of the public is one of efficiency and dedication.

ADHESIVES AGE intends to play its part in an educational campaign aimed at both industrial consumers and adhesives manufacturers. We hope to be able to stimulate further activity in the industry in this direction.

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CONSULTANT'S CORNER

By Dr. Irving Skeist

This month's "Consultant's Corner" has been contributed by Dr. Eugene W. K. Schwarz. Dr. Schwarz is associated with Dr. Irving Skeist, the regular contributor to this column, in Skeist & Schwarz Laboratories, Inc., 89 Lincoln Park, Newark 2, N. J. For his guest column, Dr. Schwarz has chosen to offer a basic discussion on the subject "Adhesives in Textiles."

Adhesion in the wider sense of the physical term—the force by which two bodies of different kinds adhere when united—is assuming an ever increasing importance in many industries. As it takes two to make a fight, so it takes two to make adhesion: the adhesive and the adherend. In textiles, as in other industries, many materials are used to effect adhesive force; this might be permanent bonding as in a laminate, or temporary, as in a masking tape (i.e., pressure sensitive tape). This adhesion might be brought about by physical or chemical means.

The oldest form of adhesion brought about by physical or mechanical means probably is that of twist in making a yarn from bundles of fibers. This form of adhesion is sometimes assisted or reinforced by the aid of chemical adhesives like glue, rosin, or synthetic resins for such products like sewing thread, or shoe laces where increased tensile strength or abrasion resistance is required.

Thermosetting Adhesives

Adhesives of the thermosetting resin type are used in making yarns without spinning. In sizing of cotton (also woolen) yarn starch of various origins are used—again sometimes in connection with rosins or resins. For rayon sizing, gelatine is used and for the newer hydrophobic fibers, polymeric materials such as PVA are used.

Coated yarns and fabrics are other examples for the use of adhesives of the type of polymers of all kinds, such as vinyls, or polyolefins for the sizing of paper. In the case of coated yarns and fabrics we have a special situation, where the adherend is also the adhesive or vice versa.

In the fast growing field of non-woven fabrics, the adhesive is actually the critical material. It is called the binder because it furnishes the adhesion of the fibers on which the strength and other prop-

erties of the material depends. There are a great many adhesives used in the manufacture of non-woven fabrics, although in some cases the fiber itself might be the binder or adhesive. There are three classes of these adhesive systems for non-woven fabrics:

(1) *The solution type binders.* They may be water-soluble products such as alginates, casein, glue, starch, and polyvinyl alcohol, or solvent-soluble substances such as rubber dissolved in benzene.

(2) *Thermoplastic fibers.* These become soft and plastic when heated, and they act as binders when present in the web. Examples are, vinyl fibers, such as vinyon (a polyvinylchloride/acetate copolymer), polyvinylchloride ("Rhovyl"), vinylidene copolymers ("Saran", "Velon"), and polyethylene fibers. Cellulose acetate fibers also are used. For a while, special plasticized acetate fibers had been used for this purpose. It is interesting to note that polyamide and polyester fibers also can be used as binders.

(3) *Thermosetting and thermoplastic resins.* They are used either as dry powders or as aqueous emulsions. Some of these are natural and GR-S type synthetic rubbers; synthetic latices based on polyvinylchloride or acetate; the polyacrylics and polychloroprene rubbers; nitriles and copolymers. Much research is going on to improve qualities of binders as well as produce lower priced products. One of the later developments is a butadiene-styrene latex, which is also used for other purposes, like carpet backing with good tensile strength.

Metallic Yarn Manufacture

Adhesion is an important consideration in the manufacture of metallic yarns. These are generally made by "sandwiching" metal (aluminum) foil between two layers of a transparent plastic film. The latest film for this use is "Mylar" which by its excellent all-around properties produces a film and a metallic yarn of superior performance. These yarns stand all processes of vat dyeing, scouring and other textile manufacturing processes and are used in a great variety of articles such as towels, shoes, curtains, automotive upholstery, etc.

About the Author . . .

EUGENE SCHWARZ has held textile research posts with Sears, Roebuck and General Dyestuff Corp. At present, he is president of Skeist & Schwarz Laboratories, a Consulting firm specializing in synthetic polymers, man-made fibers, dyes and plastics. Co-editor of "Textile Auxiliaries," published in 1958, Dr. Schwarz also edited the first "Rayon Handbook." He received his Ph.D. from the University of Erlangen, Germany in 1923.

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Elastomeric Adhesive

Porous and non-porous surfaces of many different types may be contact- or hot-bonded with a new elastomeric type adhesive designated EC-1357. It can also be utilized as an adhesive for sandwich construction structure in which aluminum sheets are bonded to impregnated kraft paper honeycomb. The material has a rapid strength buildup rate, high adhesion to steel, high softening point, good sprayability, and excellent resistance to plastic flow. Gray-green in color, it has a thin syrup consistency and weighs about 7.0 pounds per gallon. Heat resistance of the material is up to 160°F. On tests of canvas to steel bonds, peelback strengths at 96 hours aging at room temperature are 15 times those obtained with a two-hour aging at room temperature. *Adhesives, Coatings & Sealers Div., Minnesota Mining & Mfg. Co.* **P-75**

Plastic Foam Bondant

All danger of solvent attack on susceptible polystyrene foam cells is eliminated with Bondmaster G459, a water-dispersed formulation for bonding Styrofoam, Dylite and similar materials to themselves or to other materials. Bonds made with this static body adhesive maintain strength throughout a temperature range of from −35° to 250°F. as well as

during short-time exposure to temperatures up to 350°F. The nonflammable mastic adhesive may be applied with: shallow-tooth notched trowel, smooth trowel or spatula, 1/16" V-notch spreader, caulking gun, push box, paint roller, brush or spray gun. It may also be used for bonding insulating and sound-deadening materials, such as Fiberglas, saturated felt, Foamglas, etc., to themselves or to other surfaces. *Rubber & Asbestos Corp.* **P-76**

Labeling Tape

Time Hi-Temp Tape is fabricated of heat-resistant fiber and impregnated on the reverse side with heat-resistant adhesive. Cut to label size with scissors, this pressure sensitive product will take pencil, ink or ball point impressions. It does not age, discolor or deteriorate within a temperature range of −70° to 550°F. It is said to be especially useful for labeling objects associated with procedures involving oxidation, quality control, accelerated aging, atmospheric conditioning, acids or alkalies. It is available in 300" rolls of five widths ranging from ½" to 2". *Professional Tape Co., Inc.* **P-77**

Marine Sealer

Boat leaks can be quickly and efficiently sealed off with Tarp-Seal, a neoprene liquid marine sealer. When used on deck and hull seams, the old compound is cleaned out and a primer coat of sealer applied by either brush or bottle. If the seam is wide and deep, caulking line can be made by soaking soft cotton line in Tarp-Seal and then hanging it up to dry for 24 hours. Caulking line is then run into the seam and Tarp-Seal Mastic Sealer applied over it. The neoprene sealer can also be used to repair torn boat covers or tarpaulins, and to canvas a deck or cabin top. It is not affected by gasoline, oil grease, chemicals, salt water, atmospheric heat, cold or snow. It is non-flammable and does not readily evaporate. Available in white, black or mahogany. *Tarp Seal Adhesives* **P-78**

Surface Coating

Eccocoat C 26 is a clear epoxide surface coating said to have ultra-high temperature properties. It can be used continuously at 500°F. and for short periods at temperatures up

to 600°F. Surface resistivity is above 10^{15} ohms at room temperature and remains about 10^{14} even at 500°F. Moisture and chemical resistance is outstanding. Multiple coats can be used to build up thickness, but a maximum of seven mils should be applied in a single coat. Application is by dip, brush or spray. Eccocoat C 26 can be used for coating printed circuit boards, electronic circuits and components, metals and ceramics. It can also be used in place of varnish for dipping or impregnation of coils or motor windings. The coat will adhere to a wide variety of materials. *Emerson & Cuming* **P-79**

Epoxy Resin Bondant

A specially compounded general purpose adhesive based on epoxy resins, Amphesive 801 consists of Amphesive 801 Resin and Amphesive Accelerator which are mixed in proper proportion at the time of use. It bonds to a wide variety of rigid materials including glass, all metals, concrete, ceramics, wood, and almost all plastics. Shear and tensile strengths greater than 3000 pounds per square inch can be obtained with most of the above materials. Since it contains no volatile solvents and has practically no shrinkage on setting, it can be used as a filler or potting compound. Adhesion is developed within 24 hours at 77°F. However, the curing time may be shortened to 20 minutes by heating adherends to 190°F. At temperatures of 70°-80°F., compounded Amphesive 801 has a pot life of from 30 to 45 minutes. Application of the adhesive is by brush or spatula. *The Atlas Mineral Products Co.* **P-80**

Concrete Adhesive

An epoxy formulation, Metaseal Concrete Adhesive is especially designed to bond new concrete to existing concrete. A one-coat brush application to a previously cleaned surface prepares it to accept new concrete. The adhesive eliminate the need to roughen up the old concrete surface. It may also be used to bond new concrete to wood, glass, metal and all types of masonry. Because it is completely impervious to water and alkali, it may also be used by itself or with concrete in waterproofing. Tests made in accordance with ASTM specifications determined that the bond strength it affords was at all times greater than the strength of the concrete itself. *American Metaseal Corp.* **P-81**

Epoxy Repair Kit

An easy-to-use repair kit makes use of a special Hysol epoxy compound in the repair and modification of bowling balls. Changing the grip, repairing gouges and correcting balance are but a few of the possible applications. The altered bowling ball will withstand severe impact and abrasions with no loss of adhesion. Known as Invisiball, the kit is designed to eliminate blemishes on the surface of the ball, and prevents its value from dropping after repair or adjustment. *Houghton Laboratories Inc.* **P-82**

Envelope Gums

Because they have excellent humidity resistance, No. 1246 Back Seam Gum and Rapidex, a front seal gum, can be used all year round in all geographical areas. Offering excellent stability, the back gum is free flowing and clean machining in the gum box. It adheres to all envelope papers and is ideal for kraft papers, where strong adhesion is necessary. No. 1246 can be used on all rotary machines. It remains on the surface of the paper and does not soak into the fibers. As a result, there is no strike-through and pin-point blocking on low-porosity papers.

Rapid drying and fast machining speeds characteristic of Rapidex make it available for use on high-speed envelope machines as well as regular equipment. Tests show that it will dry and machine at tachometer

speeds up to 600 envelopes per minute with low heat. Furnished in Fast Drying and Flat-Seal formulations it offers four viscosity grades in each: heavy, medium, medium light and light. Accordingly, envelope manufacturers can switch grades with seasonal climate changes. *Morningstar-Paisley, Inc.* **P-83**

Unit Packaged Epoxy

The tube-within-a-tube packaging arrangement of Fix-Mix makes it possible for the epoxy resin and curing agent of this adhesive to be contained within a single plastic tube. In use, the inner tube of hardener is squeezed to force its contents into the outer tube which is then kneaded in both hands for a minute. The pointed end of the tube can then be snipped off and the adhesive squeezed out as required. Bonding applications with Fix-Mix include: ceramic, glass, metal, rubber, jewelry, plastics, etc. *American Metaseal Mfg. Corp.* **P-84**

FOR MORE INFORMATION on the new adhesives described here, use the Reader's Service Card elsewhere in this issue.

Polysulfide Sealant

The 400 series of Resiweld Sealants are based on Thiokol polysulfide liquid polymer and are said to feature longer life and better properties than earlier sealants. Available in black (400), tan (401), and aluminum (402), these sealants are two-com-

ponent systems which mix readily and are applied in a pasty, non-flowing consistency by caulking gun, pressure gun, spatula or putty knife. When cured, they set to a permanently firm, flexible, non-tacky synthetic rubber which will not tear or break loose even when subjected to vibrations, shock or temperature cycling. Can be used on metals, glass, stone, concrete and wood. They are said to be excellent adhesives as well as sealants. *H. B. Fuller Co.* **P-85**

Nuclear Plant Bonding Agent

A new bonding agent that is made of vinyl, plasticizer and a blue dye, has been developed for use in buildings that have radiation problems. Applied with a paintbrush, it makes possible the quick erection and dismantling of masonry walls. Since it is much thinner than mortar, the blocks can be fitted more closely together to prevent low-level radiation leakage. *California Stucco Products of New England.* **P-86**

Surface Protector

Applied to glue clamps, conveyors, belts or spray booths, Zipcote Stik-Pruf Coating makes it easy to strip off any accumulation of glue, paint, lacquer, varnish or other similar materials. It can also be used to protect work tables from glue or paint. Application of this non-inflammable product is by brush or spray. It is available in one and five gallon sizes as well as in drums of 55 gallons. *Adhesive Products Corp.* **P-87**

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capitol cues

SIGNS OF A SLOWING IN BUSINESS RECOVERY have shown up during the last month or two. But economists don't believe this means that the upturn is petering out. They continue optimistic despite the fact that factory output is rising more slowly than last fall...employment shows little bounce... unemployment stays high...and new car sales have been slow to get rolling.

But the economy's strengths are thought to outweigh softness:
- Consumer incomes are rising, and people seem willing to buy.
- Retail sales got a lift with holiday business and have rolled on since. And car sales have begun to move fairly briskly.
- Inventory buying is quickening, as businessmen build stocks cut in the recession. This will give manufacturing a lift.

So Washington sees no need to revise its forecasts on steady growth in total business activity. The economy will expand 8% this year, to $470 billion. Personal income seems sure to rise $20 billion, to $374 billion. The biggest gain in the economy probably will come in corporate profits, which will jump some 30%, to around $47 billion—near the record.

EISENHOWER'S BUDGET WON'T SLOW BUSINESS very much. To be sure, it is an economy Budget, slashing spending by $4 billion for the coming year. And increases in expenditures were widely considered necessary for an upturn. But, Ike's Budget won't stay in balance. Congress will vote for more money. More importantly, there'll be jumps in things the government can't control—spending for farm price supports, debt interest, veterans' benefits, added money for the military. Net, federal spending is not likely to fall at all.

THE STATES WILL SPEND 9% MORE THIS YEAR, an added factor in offsetting cuts in U.S. outlays that Congress may allow to take effect. Those state legislatures that are meeting this year will vote some $3 billion in extra outlays, according to reports from the various capitals. This sum will be a substantial plus. The borrowing thus made necessary will add further lift.

TIGHTER MONEY AND HIGHER INTEREST RATES are coming in months ahead. In the past half-year, as recovery got rolling, rising sales brought in cash with no big jump in inventory or other outlays. So credit needs were light. But now demand for credit will go up as the pick-up quickens its pace.

Nearly every type of borrower will be wanting more credit in the near future. Businessmen must build up their inventory, and they'll need more for financing new capital investments. The Treasury needs new cash; home-builders will need a lot of credit for financing mortgages; and consumers will need credit for hard-goods purchases. Demand will outstrip new savings.

Monetary officials will be taking successive steps to tighten credit. For the time being, they are moving cautiously; they don't want to slow the recovery. A rise in the discount rate —which the banks must pay when they borrow from the Federal Reserve System—may be the first step in tightening. Interest rates will be rising and may go up a half percent this year.

capitol cues (cont'd)

DON'T BE MISLED BY THE STABLE PRICE INDEXES you will see in months ahead. They will mask some big price changes. On one hand, there will be large decreases in food costs, compared with last year when frost ruined crops and boosted prices. Offsetting these drops, on the other hand, will be increases in many manufactured goods and in rents, transit fares, and other services. The trouble is, the dips in food will be temporary while increases in other costs will probably come to stay permanently.

Some items which are likely to cost more this year:

- Liquor: Prices will rise 3-5%. A new law allows distillers to keep whiskey in bond longer without being taxed. Makers expect an end to dumping practices and resulting price wars.
- Oil products: Look for hikes of 2-3%. New Venezuelan taxes and wage increases in this country will boost crude prices.
- Metals: Wage costs will be rising. And reviving demand will allow nonferrous producers to recover some of the higher costs they absorbed in the recession. Aluminum will go up 2¢ to 3¢ a pound; copper, by 1¢; nickel, by 3¢; lead, by ½¢.
- Cotton: Bigger plantings may cut prices 3¢ to 4¢ per pound.
- New homes: Wages and materials costs are rising while house sites are getting scarcer and costlier. Net? Gains of 4-5%.
- Used cars: With used car buyers more numerous than new, the present upturn is boosting demand faster than trade-ins can meet it. Yet late models are few. So prices will be firm.

BIG GAINS IN PRODUCTIVITY NOW BEING REGISTERED will help keep prices of nonfarm items and services from going higher than forecast. New figures show that output per man-hour for workers in manufacturing went up by 6% last year; for all workers—including overhead—the gain was only 3%. The rises in 1958, centering in the second half, were about 50% greater than in 1957.

The continuing trend to automation and the shakeout of work forces in the recession were the prime reasons for the 1958 increases. Industry is discovering that it can turn out an expanding volume of goods with slightly augmented workforces.

THIS WILL BE A BIG YEAR FOR AMERICAN EXPORTS say government experts. Total merchandise shipments probably will go up around 8% during this year, to around $17.5 billion. Items that will benefit most will be grains, small appliances, industrial chemicals, machinery, and fabricated metals. Europe's purchases will increase the most, but solid gains are coming on shipments to Canada and Asian countries. U.S. imports will also be rising—around 10%.

CORPORATIONS WILL PAY BIGGER DIVIDENDS this year—perhaps 10% or 15%. This will more than reverse the downturn of some 2% that took place during 1958. Corporate profits will increase even more, around 30% to 35%, but the payout to stockholders will be held down in order to rebuild cash positions.

A CRACKDOWN ON DEDUCTIONS FOR BUSINESS EXPENSES is being waged this year by the Internal Revenue Service. The U.S. tax agents are launching another drive to halt expenses not "necessary" to the conduct of a business. This means they'll be tough on such deductions as those for football games, yachting trips, winter cruises, summer homes, etc. Businessmen will have to have plenty of evidence that such expenses are necessary in their businesses.

• The State Department recently emphasized how important it is to refrain from trading with Soviet Russia. Although the American steel industry has been requested to submit quotations to Russia for a pipe having a length of 12,000 miles, the management of American steel mills has refrained from doing so.

We now learn that France will supply Russia with machinery valued at $2,200,000 for making plastic articles, including extrusion presses for the manufacture of polyethylene film and polyethylene articles, in accordance with a new trade agreement between those countries covering the period from 1959 to 1962. Also to be sent to Russia will be miscellaneous equipment for the chemical and rubber industries and plants for the manufacture of synthetic fibers, etc., valued at approximately $15 million. Russia in turn will export a number of goods to France, including 1,500,000 meters of fabric for use in the manufacture of tires.

• A joint committee, sponsored by the British Institute of Welding, the Plastics Institute and the British Plastics Federation, has been organized in Great Britain in order to follow up the technological requirements of industry regarding the welding of thermoplastic materials and to suggest action which will make it possible to meet these requirements.

• Italian plastic machinery is now being manufactured in Great Britain. The Italian company, A. Triulzi, Ltd., known for its injection molding machines has licensed Baker Perkins, Ltd., Peterborough, England, to manufacture this machinery, utilizing Italian developments and design. A. Triulzi's range of injection molding machines includes units of from 1/6 of an ounce to 400 ounces capacity. Its range of machinery includes compressions and transfer molding presses, laminating and polyester presses.

• England may refund import duty for certain plastics, in view of the rising export of pipes and pipe fittings made from materials utilizing imported compounds. The British Board of Trade has considered making a refund on the raw materials when the manufactured pipes and pipe fittings are exported.

• Kleber-Colombes of Paris, France, has assigned manufacturing rights to England for its product, known in France as "Klebecell" and in England as "Plasticell." This is a closed cell, cellular PVC and is available in rigid and flexible forms. Both are manufactured in thicknesses of from ⅛ to 3 inches. Production of the rigid grades will start in England about the middle of 1959. In the meantime, all requirements for Plasticell will be imported from France.

• The English standard yard is shortening at the rate of over one millionth of an inch a year, taking that country closer to the metric measurement. Its standard pound has lost weight since its inception around 1846. The Canadian pound differs in weight from the United States pound. To secure identical values for each of these units and more precise measurements for science and technology, it has been agreed to adopt an international yard and an international pound having the following definitions: 0.9144 meter for a yard and 0.45359237 kilograms for one pound.

This decision is the result of discussions which have been held between standard laboratories in Canada, New Zealand, England, South Africa, Australia and the United States. Also, it has been agreed that unless otherwise required, all non-metric calibrations carried out by these standards laboratories on or after July 1, 1959, will be in terms of these international units. The adoption of international values for the yard and the pound is undoubtedly a move that could not have been delayed much longer. It will be of particular benefit to all who are concerned with accurate measurements. Now that we have a pound and a yard which are defined in meters and kilograms, when will the United States have the courage to adopt the metric system?

• There will be an International Plastics Exhibition in London, which will be arranged by the Design Committee of the Plastics Institute in conjunction with the organizers of the British Plastics Exhibition, and assisted by the Council of Industrial Design. The International design display will be held at the International Plastics Exhibition in London on June 17 to 27. Thirteen overseas countries have already indicated that they plan to take part in the 1959 exhibition. Further information may be obtained from the Design Centre, 28 Haymarket, London, S. W. 1, England.

• Deutsche Goldund Silber-Scheideanstalt, vormals Roessler, in Pforzheim, Germany, has been granted a patent covering adhesives for the bonding of metals. Metals, particularly those which are light in weight, are bonded together by means of adhesive compositions consisting essentially of mixtures of a liquid polymerizable vinyl compound with a terminal vinyl group; neoprene; another polymeric material; and a catalyst for hardening the mixture, preferably a Redox catalyst. Other compounds which may be added to the compositions to improve adhesion include acrylonitrile or methacrylonitrile and an ester of fumaric acid or maleic acid. It is also advantageous to add a casting resin. In examples cited, styrene was used as the liquid polymerizable vinyl compound and polystryene as the polymeric material in addition to neoprene. The German patent was published on October 15, 1958.

On the Continent

• In the field of electrical insulating materials, Farbenfabriken Bayer, AG, Leverkusen, Germany has received a patent describing the use of aromatic polycarbonates of high molecular weight as electrical insulating materials. The polycarbonates may be made by reacting aromatic dihydroxy compounds with diester of carbonic acid or with phosgene.

• England is trying to open up the Russian market and R. E. G. Windsor, managing director of R. H. Windsor, Ltd., a leading English exporter of plastics machinery, recently returned from a visit to Russia. During an interview in which he discussed his experiences in that country, Mr. Windsor said that his firm already has quite a few injection molding machines, of its small and larger pre-plasticizer type, in operation there. The firm also has a certain number of extruders in its books for delivery.

During his visit to Russia, Mr. Windsor showed a film, produced by his firm, which was entitled "Achievements in the Design and Production of Machinery for the Plastics Industry," through which he hoped to establish goodwill and to endeavor to reach technical specialists and managers of molding plants and their scientific and chemical experts. The film successfully achieved this. Eighty to ninety technical experts from various manufacturing installations were present along with the State Chemical Committee, and the State Planning Committee. Afterwards, the group had a two to three hour question and answer period at which intelligent, direct questions were asked by individuals with a sound knowledge of the plastics industries, both in America and in England, Mr. Windsor said.

According to Mr. Windsor, R. H. Windsor, Ltd., plans to conduct a similar tour next year, which will include men who will be responsible for sales and after-sales services in Russia and in Poland and Czechoslovakia, other countries which were visited. He stated that the company hopes that its service engineers will be allowed to install the machines and carry out after-sales services. The visiting group was impressed by what the Russians have achieved in the last five years and by the importance they place on the five-year plan for the chemical and plastics industries. Mr. Windsor feels that it is inevitable that injection molding and extrusion machines of the latest type will be required.

• The English Arbitration Court has rejected application for higher duties. This tribunal, which is equivalent to our tariff commission, investigated complaints made by several British manufacturers that polyethylene, polymethylmethacrylate, polystyrene and PVC have been improperly excluded from the Key Industry List J. Key Industry Duties were introduced to ensure that materials that were considered to be of strategic importance in time of war should have sufficient protection to maintain their production in England. This list was established in 1921 and at that time plastics were not considered vital materials. However, cellulose acetate has been incorporated into that list and is, thus, protected by an import duty of 33 1/3 per cent.

• In view of the increasing imports of plastics, it is understandable that British manufacturers seek protection by the same 33 1/3 per cent duty against foreign competition. However, the tribunal has rejected the application because the four important thermoplastic materials were not synthetic organic chemicals and should not, therefore, be protected by this Key Industry Duty.

The tribunal was solely concerned with the question of definition and heard lengthy arguments on this question before it reached a decision. At present, it seems to be possible to import PVC and polystryene from the United States, Japan, Italy and Yugoslavia and to sell them at 16 per cent below the British home trade prices, after paying freight charges and a 10 per cent import duty.

• Adhesives are of primary interest behind the Iron Curtain. Zentral Institut fuer Schweisstechnik der DDR, in Halle, Saale, the East-German institute for welding research, and Fachausschuss Klebetechnik, a special committee for adhesives research and development of the Chamber of Technical Research, held the second special meeting devoted to the "Technology of Adhesion," (Klebetechnik 1958) in Leipzig last fall.

More than 1000 chemists from East-Germany, Czechoslovakia, Poland, Hungary, Yugoslavia and presumably Soviet Russia attended the meeting. Participants listened to the presentation of 11 long and 18 short papers which conveyed a comprehensive picture of latest research efforts and developments. Metal bonding processes were particularly emphasized. Delegates visited a special exhibit containing many displays. Here, too, metal bonding took the spotlight. More than 600 factories in East Germany are now working on metal bonding processes.

One paper, delivered by K. Herkner, of Dresden, East Germany, stated that continuous gluing, or coating and laminating, using epoxy resins can be accomplished when undercooling the compound. He stated that undercooled, cold setting epoxy resin compounds remain in a liquid state for more than eight hours.

• Figures on the French plastics industry production and imports show that plastics production in 1957 totaled 155,920 tons, compared with 128,030 tons in 1956. Consumption increased from 159,339 tons in 1956 to 194,342 tons in 1957. In the same period, France imported 50,750 tons and exported 13,362 tons.

• Montecatini has announced plans to construct a propylene-ethylene copolymer plant at Brindisi, Italy. The plant, which is expected to be in operation in about two years, will have an annual capacity of about 60,000 tons. According to the Italian firm, propylene-ethylene copolymer is more durable than the general purpose styrene-butadiene copolymer presently used in tires. Montecatini also believes that the new rubber will cost about ten cents less, per pound, than styrene-butadiene.

letters to the editor

Metric Measure

Dear Sir:

First, my heartiest congratulations on a fine start of your new ADHESIVES AGE! The first three issues are just packed with interesting and useful information. I know of no industry where there has been such a lack of news and editorial coverage, so I am happy to see that the vacuum has now been filled.

As a European representative for an American adhesives firm, I have been even more aware of the lack of communications in our industry. So, a very large welcome to ADHESIVES AGE!

Then, I'd like to say a few words on the Metric vs. U.S.-British systems of measures. (see ADHESIVES AGE, December, 1958, p. 62.) Unless one has lived in Europe as I have for 18 months, he will never realize how simple life can be with a completely integrated, instantly convertible system of measures.

When I read American and British technical information now, I find the inches-feet-yards-miles system as primitive as the Stone Age axe. My only consolation is that we didn't adopt the British currency units, too! Why, in England, they still use the stone (14 pounds) as a unit of weight—but, at least, their gallon is based on 10 pounds of water, instead of our odd-ball 8.33 pounds.

I realize that a changeover to metric now would have far-reaching and expensive consequences, but continuing to operate with such an antiquated, cumbersome system is also expensive in time, understanding and frustrations. The only question is: How much longer can we wait?

R. S. PIPER

Minnesota de France,
Paris, France

Fish vs. Wood Glue

Dear Sir:

In the December, 1958, issue of ADHESIVES AGE there is an article entitled, "Fish Glue—A By-Product of Nature" by Hugh C. Walsh. Under the picture on page 31 the following appears: "Fish glue being applied to a furniture joint. It is the principal adhesive used by the furniture and cabinet making industry."

On page 32 the following appears: "One of the first industries to adopt fish glue as a major adhesive was the furniture and cabinet making. The happy association lasts to this day, since fish glue is still the principal adhesive used by these skilled craftsmen. The popularity of fish glue in these industries is due in great part to its high joint strength with the advantage of reasonable open time to permit assembly of multiple components."

Our company has been serving the furniture industry for over 20 years. Our sales representatives are supposed to call on all of the principal furniture factories and industrial woodworking plants east of the Mississippi River. To the best of my knowledge not once in over 20 years have we been advised that any of these factories or plants use fish glue as a production material for wood gluing. This is certainly contrary to the inescapable impression to be drawn from this article.

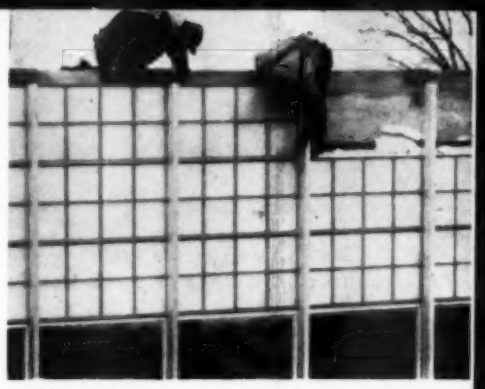
We think the impression created by this article should be corrected. We are sure that you are just as anxious to avoid publishing inaccurate information as we are to avoid receiving it.

LANGDON T. WILLIAMS
President,
Franklin Glue Co.,
Columbus, Ohio

The article to which Mr. Williams refers ("Fish Glue—A By-Product of Nature," December 1958, pp. 31-32) was a brief review article covering major fish glue applications. Mr. Williams' letter points up the fact that there is, apparently, some difference of opinion between suppliers as to the types of glues used in the furniture industry—one facet covered by the fish glue article.

ADHESIVES AGE, as a "nerve center" of the adhesives industry, hopes to provide not only confirmation of long held opinions, but to uncover areas where disagreement exists. It seems to us than in this way we all learn and profit.

—Editor.



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Guide to Adhesives Selection

With a Pictorial Checklist [√]

By BERNARD GOULD*
Member, Editorial Advisory Board
ADHESIVES AGE

"We want a high-strength adhesive for bonding metal to plastic. It must withstand high heat and cure at room temperature."

Such a request—or its equivalent—reaches the desk of the average adhesive manufacturer just about every week of the year. The potential user feels he has given a detailed description of his bonding problem; however, the prospective supplier finds such a brief listing of requirements virtually useless if he is to make a *valid* recommendation. He is then faced with two alternatives as his next move.

Makeshift Approach

As a "makeshift" approach, he can submit a "general purpose" type of adhesive which he sells to many different industries for a wide variety of bonding applications. Such a formulation might loosely fall within the extremely broad limits of the problem as it has been outlined to him.

The apparent advantage of this approach is that he seems to be giving immediate "service" to his prospect and is, at least, giving him something to experiment with. On the negative side, however, is the probability of a returned, terse evaluation report: *It didn't work*. These three words may sum up untold hours of wasted evaluation time and effort which might well have been better directed.

The second alternative, and the one which the major suppliers in the industry prefer because it assures long-term customer satisfaction, is to write back and request more detailed information.

All too often, however, the potential user is disturbed by the adhesive manufacturer's seeming inability to understand what is, to him, a simple joining problem. Why, he wonders, does a manufacturer who has had years of experience in his field require this additional information? Surely, many such problems have been encountered and solved before.

No Universal Solution

Indeed, they have. But it is this very experience which has taught the manufacturer that there is no such thing as a "universal" adhesive problem or a "universal" solution. He has learned that he cannot *assume* a number which will represent the temperature of a "hot" object—just as he cannot tell "how high is up."

Each manufacturer of industrial adhesives has hundreds of different formulations as "stock" items. The fact that these are available from stock means that they are in regular production use in one or more of his customers' plants. Hundreds of new formulations join the ranks of "stock" products each month (and other hundreds become obsolete) as new production techniques are developed within an industry or as new and different raw materials enter the market.

Polyester Film

The introduction of DuPont's Mylar polyester film, for example, or the growing use of Dow's Styrofoam as a sandwich panel core material, necessitated the development of scores of new adhesive formulations.

Why are there so many? Why doesn't one product bond the same materials efficiently and economically in every single plant all over the world?

These questions can best be answered by selecting a typical application such as the bonding of flexible foams in the furniture and upholstery industries. The applications seem uncomplicated enough and the problem appears to be one that could be universally solved with a single adhesive.

The fact of the matter is, however, that there are dozens of formulations or variations of formulations used in

Note: *Mr. Gould is Manager, Market Development, of Rubber & Asbestos Corp., Bloomfield, N. J. The pictures used in this article were provided by R&A and are printed here by their courtesy.

this one industrial field. Some formulations were developed for bonding urethane foams and latex foams to themselves or to each other, and some for bonding these foams to rigid materials such as wood or metal. To speed automated production, formulations incorporating extremely fast-drying solvents are available. Other formulations are designed to work with tie-coats to hold back plasticizer migration from vinyl foams. There are scores of other examples.

Delaying the Recommendation

So, it is actually the *more* experienced adhesive manufacturer who is likely to withhold his recommendations until he can determine which of his many products will most efficiently and economically meet the individual needs of the potential user.

Each adhesive manufacturer publishes detailed Technical Data Sheets as well as elaborate charts which describe the physical specifications of various formulations. The latter often incorporate detailed recommendations regarding application techniques. In addition, every few months one or another of our industrial magazines publishes a "selector chart" with complex groupings of chemical families, design considerations, viscosity ranges, and the like.

However, most adhesive suppliers emphasize the pitfalls involved in using such printed material as a *final* guide to selecting adhesives for production. The many charts and tables themselves are usually carefully annotated with warnings to the reader that they are merely meant as guideposts along the road, not definitive recommendations.

Accomplishing the Job

It is true that within the broad limits of the problem described at the beginning of this article, there are many adhesives that will "do the job." However, simply "doing the job" probably isn't enough.

As the problem becomes more sharply defined, individual adhesives can be supplied which are "custom-tailored" to the application or even to the specific, individual plant operation. Because it is important for the formulator to be able to provide such specialized products, substantial, industry-wide investments have been made in research and development. This activity confirms the fact that in the current state of the art, proper adhesive selection depends on more variables than can be incorporated into a simple chart or checklist of impersonal specifications.

The ability of the adhesive supplier to solve a bonding problem is in direct ratio to his understanding of all the parameters of the problem. Frequently, however, the basic roadblock appears to be one of faulty "communications" rather than of technical interpretation. Adhesives are used in so many different industries, for so many different purposes, and in so many different ways that the definition of a seemingly simple term often achieves major importance.

The term "high strength" may mean five psi to the plastic coat hanger manufacturer, 500 psi to the high fidelity loudspeaker manufacturer, and 5000 psi to the designer of machine parts. In addition, even a numerical designation of strength means little unless the *type* of strength is clearly indicated. Epoxy-based formulations, for example, are among the leaders in providing high-shear-strength bonds, but they are relatively weak in peel strength.

Terminology Differences

The simple phrase "high heat" may mean Florida sunlight to one manufacturer and the boiling point of water to another. It may describe the 300°F. range to the aircraft manufacturer and the 500°F. range to the missile manufacturer.

Even after all the basic terms have been defined, so many variations may still exist from plant to plant (processing techniques, skill of workers employed, even local atmospheric conditions) that the adhesive which performs with outstanding success in one plant may show deficiencies under the conditions encountered in another. This may be true even though both users are ostensibly manufacturing the same product in what appears to be the same way.

These examples begin to reveal some of the reasons why the adhesive manufacturer sincerely interested in serving you best may prefer to delay his submission until he gets more information. Only *you* can tell him what he must know in order to give you a "custom-tailored" answer to your problem.

Regardless of the industry involved, the selection of the proper adhesive for production, or the selection of the proper adhesive submission on the part of the supplier, depends basically upon the answers to three key questions:

(1) Which materials are being joined?

(2) How is the completed assembly expected to perform in end-use?

(3) What method of adhesive application is most suitable?

These key questions—and related supplementary information your adhesive supplier needs to know—are more fully explained and illustrated on the following pages.

Of the three, the fullest amount of detail is necessary in specifying the end-use properties required of the completed assembly. Within limits, it is then possible to select the desired form of the adhesive (liquid, paste, powder, film); the method of application (by trowel, brush spray, etc.); and to determine its adaptability to your production scheduling and equipment.

A final admonition: let's be practical!

Tell your prospective supplier why the formulation you are using, or those you have evaluated so far, proved unsatisfactory. Equally important, tell him the name and number of those products. Each adhesive maufacturer has a number of basic formulations which are "similar" to competitive products. When you tell him what you have already rejected and why, you have narrowed down his "universe" of selection. In so doing, you will have helped save your own valuable evaluation time by eliminating new submissions which are predestined to failure.

Remember too, the manufacturer's lab time costs money. Is your projected volume sufficient to warrant development of a new adhesive if one of his standard products doesn't answer your needs? He'll be more than willing to formulate an entirely new approach for you, but there must be dollar volume (and profit!) there to warrant it.

Finally, indicate where you can compromise. You may have to sacrifice some *desirable* properties to get essential properties in your adhesive.

To summarize: the effectiveness of the "feedback" help you can expect to receive from your adhesive supplier is directly related to the quantity and clarity of the information you feed in. When you help him to help you, you pave the way for more fruitful evaluations in your lab and —of even greater importance—more economical and efficient bonding production in your plant.

Guide to Adhesives Selection—

A Pictorial Checklist

What Materials Are Being Joined?

Styrofoam to Aluminum?

By providing your supplier with exact information, you get faster and better service. The problems involved in bonding a plastic foam differ from those affecting a typical rigid plastic operation, and entirely different adhesive families may be needed.

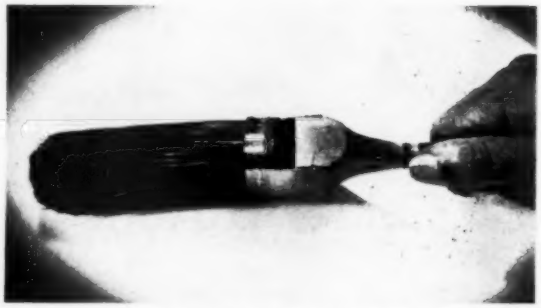
Teflon to Steel?

Be specific! Don't just say, "We want to bond plastic to metal." This sort of vague description of your operation will not help your adhesive supplier to pick the bondant best suited to your particular needs. If possible, send samples.

[turn the page for a point-by-point analysis]

What Are the End-Use Service Requirements?

How hot will it get in service? If the assembly must withstand high temperatures only intermittently, there is no need to pay more for an adhesive meant for high temperature jet aircraft.

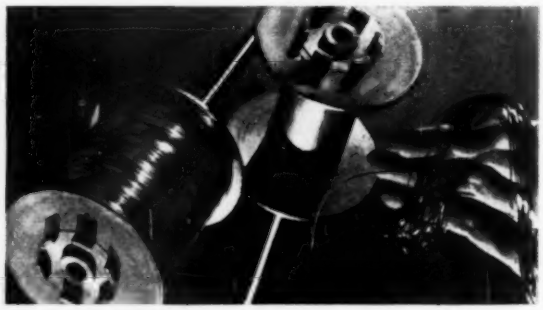


Which chemicals must it resist? For example, adhesives used to manufacture paint brushes are meant to withstand extended submersion in some of the most punishing solvents known.

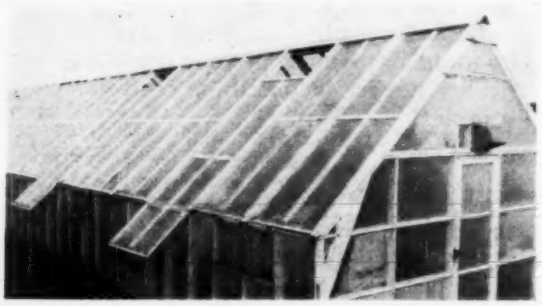
Must it resist outdoor weathering? Building panels take a beating, but so do pressure sensitive auto bumper strips. Factors such as sunlight, wind, rain and aging, should not be overlooked.

How flexible must it be? Foam cushioning obviously needs a "soft seam" adhesive. However, because of differing thermal expansion coefficients, flexibility is also a factor in glass to copper bonding.

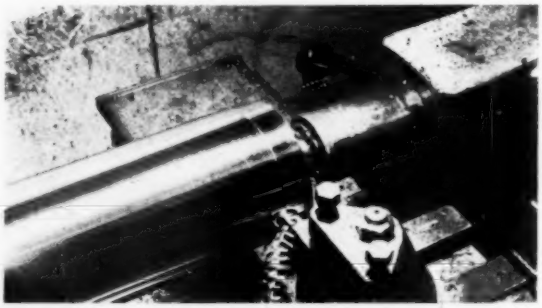
Any taste, odor, or toxicity problems? Adhesives used for most food packaging must, when dry, not only be non-toxic but odor-free. Good "housekeeping" is important here, too!



Any color problem? Permanency of color is often a prime requisite. For example, there must be assurance that exposure to sunlight will not fade the color of the adhesive in metallic yarn.

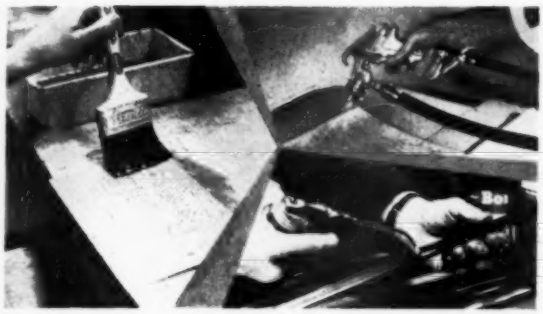


How strong must it be? If the materials being joined will rupture at 1000 psi, there is no need to specify adhesives designed to withstand 3000 psi. Over-designing costs money!



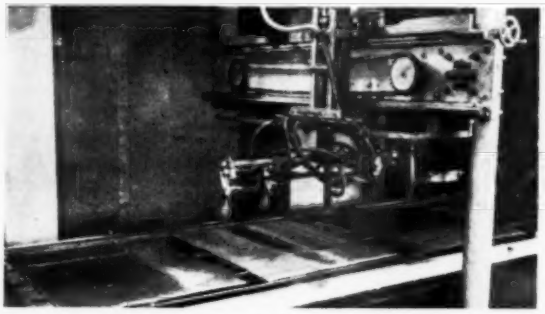
What kind of strength is needed? The type of strength required (peel, shear, etc.) is important. For example, in a carbide cutting tip bond peel/cleavage strength is a "must."

Which Production Method Will Be Used?

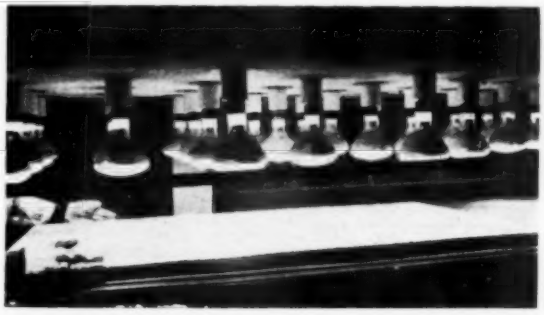


How will the adhesive be applied? Brush? Knife? Trowel? Spray? Dip? Roller coat? Extrusion? This information is important in helping the supplier select a suitable adhesive.

Is hand application involved? In many cases the type of application will determine the "working life" range required of the adhesive used in a given operation.

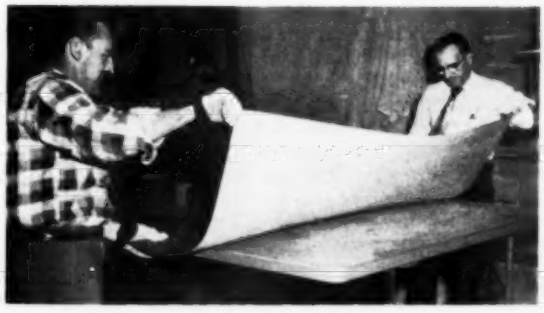


Is machine application involved? Viscosity, or the internal frictional resistance of an adhesive to flow, can be an important factor in the success of any machine application.

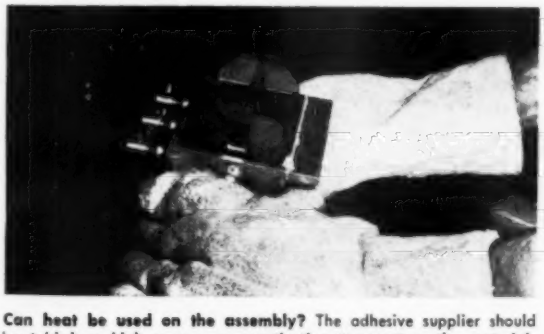


Are force-dry procedures to be used? If production scheduling demands faster drying speeds, the adhesive supplier can often be of help by selecting a bondant which meets this requirement.

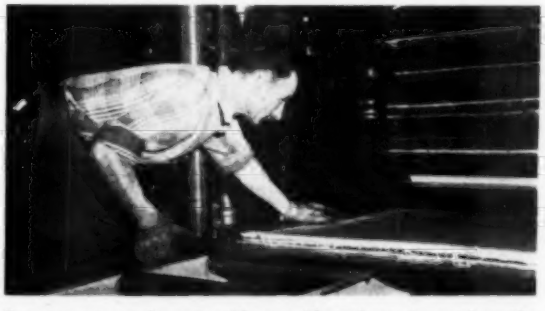
Are air-dry procedures to be used? How much drying time is allowed for in the production schedule. The supplier may also want to know temperature and humidity conditions within the plant.



Does the operation call for immediate or delayed bonding? What are the minimum and maximum "open times" between the application of the adhesive and the actual assembly of the components?

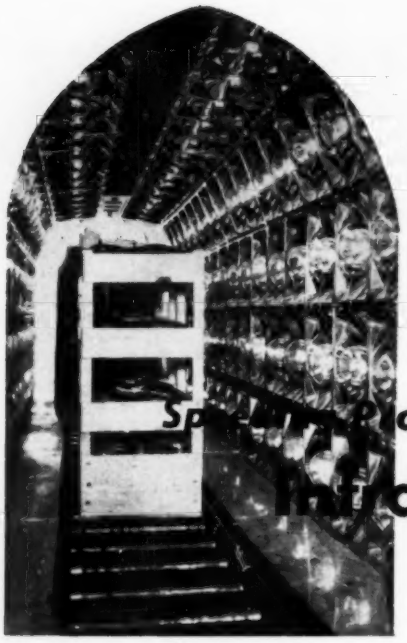


Can heat be used on the assembly? The adhesive supplier should be told how high a cure or reactivating temperature the materials will stand, as well as for how long?



Can pressure equipment, with or without heat, be used on the assembly? Not only how much pressure is available for the operation, but how much the components will withstand should be specified.

All photographs courtesy Rubber & Asbestos Corp.



The drying time for adhesives applied to shoe bottoms and soles is cut in this infrared oven through which shoes are moved on racks.

Speed Production with Infrared Curing Techniques

By P. H. KRUPP
Manager of Infrared Marketing
The Fostoria Pressed Steel Corp.
Fostoria, Ohio

New adhesives have immeasurably expanded the possibilities for faster, more economical and improved production lines. At the same time, however, they present some challenges from the standpoint of machinery and processes to facilitate the bonding operation. One of these pertains to the application of heat on the production line.

The engineer or production man confronted with heat-processing problems must decide what type of heating equipment best meets modern-day standards. Obviously he wants heating equipment that will do the job the fastest, be most flexible, require less floor space, operate at costs comparable with other equipment, and be of reasonable initial cost.

Electric infrared radiant heating is one of the more efficient methods available to the adhesive user. It differs from other heating methods in that it heats the product directly without heating up the surrounding air. As a result it is faster, and more of the heat paid for is actually used. Contrary to some mistaken notions, electric infrared is actually *more* economical.

For example, when the electric infrared oven is turned on it starts heating the product immediately. Conversely the heating effect is terminated as soon as the oven is turned off. The technique therefore permits instantaneous control of the heating effects. It also makes possible the use of several electrical devices to alter the voltage and to cycle it at various rates to change the heating effect. Other than variation in line voltage, there is little that can happen to electrical infrared systems to disturb steady control of heating effects.

Types Of Equipment

There are two types of electric infrared equipment which have become generally accepted as suitable for most industrial heat processing jobs. These include (1) equipment which uses regular medium screw base heating lamps, and (2) linear, tube shaped heating elements, including quartz lamps, quartz tubes and metal resistance heaters.

The medium screw base lamps are available in various sizes, to permit heating at variable rates from approximately 148 to nearly 600 watts per square foot (input rate).

The linear heating elements permit heating at variable rates up to approximately 3400 watts per square foot (input rate). The application of heat at the higher rates is only required where webs are moving at high speeds and, consequently, the dwell time is extremely short.

It should be remembered that with electric infrared systems it is possible to direct the energy to areas to be heated. In contrast to conventional type ovens, properly designed infrared ovens permit variations in heating for different areas of the oven or product. Electric infrared systems have been incorporated as part of completely automated production lines.

The following industrial examples will be of interest to those considering the use of modern adhesives on the production line. They illustrate the results obtainable when electric infrared is used for various drying and curing jobs.

A number of companies who

Note: Photos used here are by courtesy of The Fostoria Press Steel Corp., Fostoria, Ohio

manufacture office furniture are using electric infrared ovens for drying or setting the adhesive, prior to bonding decorative desk tops to base materials of plywood, steel or paper core stock. Generally speaking, the adhesives used for those jobs require approximately one minute of heating to get required temperatures for satisfactory bond.

At Art Metal Construction Company, Jamestown, N. Y., the production line for formica-topped desks and tables includes a 22-foot infrared oven of the quartz type. Wired for 480-U service, the unit makes possible a drying cycle of only a minute and a half.

A similar installation in the Dishwasher and Disposal Department of General Electric Co., Louisville, Ky., is used to set adhesive applied to Textolite and to one side of a steel sheet. After the adhesive is dried, the two sheets are placed back to back and permanently bonded by pressure through pinch rolls.

Altering Speed

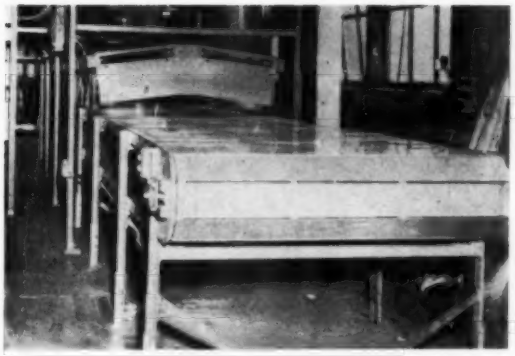
Drying time can be varied by altering the speed of the oven's conveyor belt. Since the maximum conveyor speed is 15 feet a minute, and the oven length is 22 feet, the shortest drying cycle is approximately one and a quarter minutes. The oven has 250-watt lamps set throughout its length.

In the manufacture of cartons, pressure sensitive adhesives can be dried in a matter of seconds with high intensity tubular type heat sources. The basic heating job for such applications is the removal of solvents from the adhesive to the point of tackiness, so that bonding of tapes can be effected.

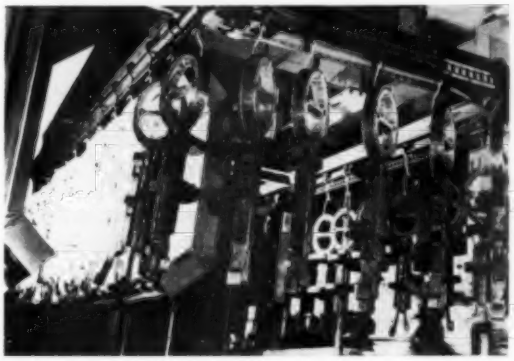
The fastening of covers to the back of books is a common application for adhesives. Today, book covers are applied at high speed with modern machinery. Mechanical handling devices dip the books into the adhesive, and the books then proceed through an electric infrared oven to dry sufficiently for application of the cover.

The use of modern adhesives in the manufacture of shoes has permitted many changes in traditional techniques. The newer adhesives offer such strength that it is impossible to tear the sole from a shoe when the cement has been properly cured.

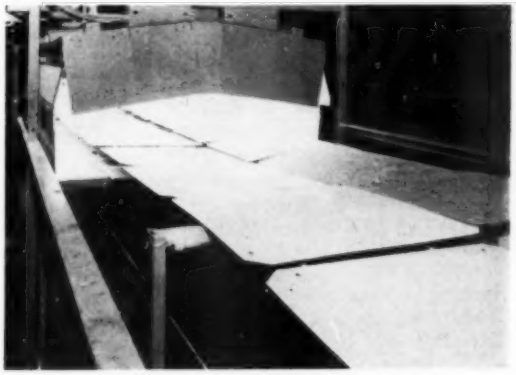
Depending on handling methods employed in the factory, the drying time for adhesives applied on the



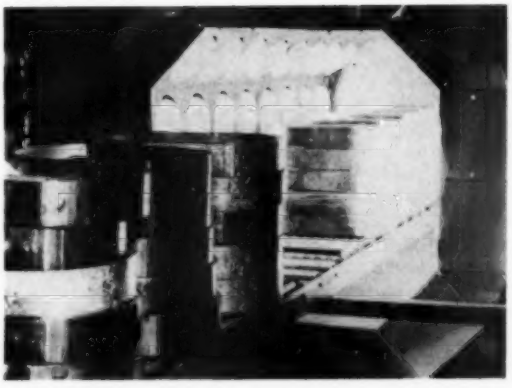
Adhesive applied to Formica desk and table tops is dried in this 22-foot infrared oven on the production line of Art Metal Construction Co.



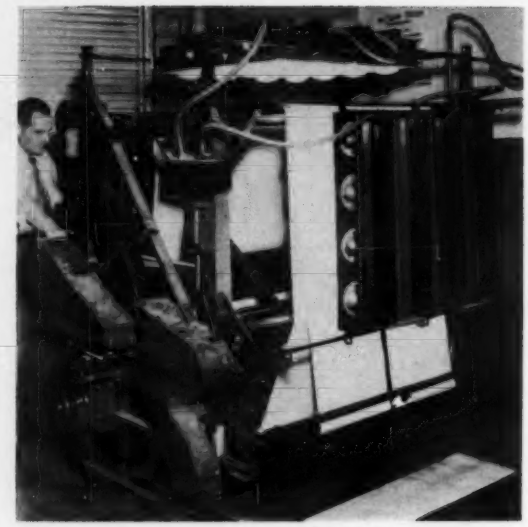
At MacGregor Goldsmith, tennis racket forms containing eight strips of adhesive-coated wood move through the infrared oven on an endless chain.



GE's Dishwasher and Disposal Dept. uses radiant heat to dry coated sheets of Textolite and steel which are then bonded by pinch-roll pressure.



Rubber cement bonding new linings to reclaimed brake shoes is dried in only 12 minutes by an infrared oven at Stevenson Mfg. Co.



Infrared setup is used to dry rubber cement on top stock used in the manufacture of volley balls by W. J. Voit Rubber Co.

bottoms and soles may vary from a few seconds to approximately five minutes. Many shoe manufacturers stick to the rack system of carrying shoes through the drying oven; others employ horizontal belt conveyors.

Wherever adhesives are used in the manufacture of shoes, electric infrared equipment can be applied to speed-up drying and thus turn out maximum quantities with minimum lasts.

Foam rubber bonded to itself or to other materials is a common component in the manufacture of many items today. Whether the adhesive is applied in a narrow band or over large areas, infrared has always been found an efficient curing method.

In recent years nonwoven fabrics are being used in a variety of applications to replace conventional woven textiles. Nonwovens are made of chewed-up textiles or synthetic fibers bound in a layer with an adhesive. Electric infrared has been used extensively to drive the solvent out of the adhesive and later dry it. The two-stage heating operation may vary from 20 to 60 seconds, depending upon the particular job.

Vinyl plastic sheet material has been widely adopted for many products where decorativeness and strength are required. Decorative vinyls are being combined with steel and aluminum for such items as interior automotive trim, card table tops, luggage, waste baskets, radio and television cabinets, office furniture, record players, etc.

Production lines for bonding vinyl to metal are sometimes of the continuous strip type, traveling at high speeds. In other cases, single sheets of various sizes are laminated. Both operations require modern adhesives to combine the dissimilar materials. The drying time with electric infrared will obviously vary slightly with the gauge of the metal, but normally an estimation of from 45 to 60 seconds can be relied upon.

Automotive Application

Infrared has been used many years for curing the adhesive that holds automotive brake bands to metal brake shoes. Since the band must be held securely to the shoe with a clamp, the infrared must penetrate the complete assembly and attain temperatures of 350° to 400°F. Bonding can be done in as short a time as three minutes.

In the plant of one Minneapolis replacement supplier, a 4-foot 4¾-inch infrared oven can turn out 70 completely cured units every 12 minutes. The oven uses 375-watt lamps for a connected load of 24 KW.

Manufacturers of envelopes have found electric infrared the ideal way to dry glue lines, and it is safe to say that most of them have adopted it in the last several years. In many cases infrared has replaced other drying mediums on existing machines. Machine manufacturers are now building infrared as an integral part of the original models. Drying times vary from two to seven seconds.

A large variety of paper items, such as labels, tags, stamps, etc., require applications of some type of adhesive and subsequent drying.

The installation of a combined rubber cement coater and infrared drying unit at W. J. Voit Rubber Co., Los Angeles, Calif., considerably reduced the time required for one important operation in the manufacture of volley balls. Top stock moving at the rate of 15 feet per minute first passes over a coating roller and then in front of eight sections of 250-watt infrared lamps. In four hours, one attendant can produce all the stock required for a day's production. Previously the same operation required the time of six people working a two-shift day.

One of the modern tools on the production line of MacGregor Goldsmith, Inc., Cincinnati, Ohio, is an infrared oven used to force dry glue in laminated tennis racket frames. Eight coated strips of wood are placed in forms which move through the nine-foot two-inch oven on an endless chain conveyor. The solid racket form is completed in eight minutes. Air drying time for the same operation would be eight hours.

Possible applications of electric infrared radiant heating are as limitless as those of adhesives themselves. As from the test tubes come new lines of adhesives which permit manufacturers to join similar or dissimilar materials with almost any degree of strength, the practical advantages of a modern heating technique become more and more obvious.

About the Author . . .

PAUL H. KRUPP has been associated with Fostoria Pressed Steel Corp. since 1941. He is a frequent contributor to industrial magazines and is often called upon by technical societies to discuss various aspects of infrared. "Radiant Heating News" is published under his direction.

Adhering Dacron to Rubber
Part Two—Commercial Evaluation

Laboratory testing of an aqueous adhesive developed to meet a special industry need

By LOWELL W. PARKE

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Wilmington, Delaware

Because of their unique physical properties, man-made fibers have been evaluated to establish their potential in satisfying the increasingly higher performance requirements of both industrial and automotive V-belts. Dacron polyester fiber, with its particular combination of high strength, high modulus and good fatigue resistance, was found to be outstanding among the synthetics in the field of V-belt reinforcement.

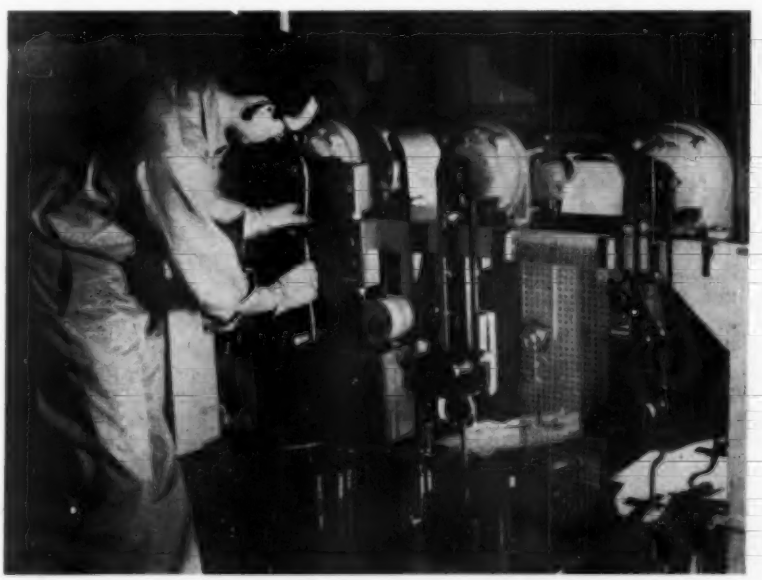
However, a primary limitation on its early use in the industry was the fact that the resorcinol-formaldehyde-latex adhesives (RFL) most commonly used as cord-to-rubber bonding agents did not provide sufficient adhesion.

Research leading to the development of an aqueous blocked-isocyanate Dacron-to-rubbed adhesive was reported (1) in the February issue of ADHESIVES AGE. The following article describes the commercial evaluation of the new adhesive. An examination of the results shows that it increases belt service life and permits the utilization of the desirable properties of Dacron as a V-belt reinforcing fiber.

The adhesive evaluations were made with "B" cross section V-belts of the cable cord type. Gray cords were prepared in an 1100/2/5 construction twisted to 3.1 "Z" by 2.7 "S" turns per inch. A standard multiple end Kidde dip-stretching machine was used to establish cord treating conditions and prepare dipped cords for evaluating the adhesive.

Single end cord adhesion values were measured by the strip test method described in Part I of this article. The level of strip adhesion values differ from those reported by Thompson, Marshall and Sweet because their work was based on 220/4/2 industrial cord rather than 1100/2/5 V-belt cord. Belts were built with a 46-inch nominal length, then fabric covered and ring cured in open steam at 340°F. for 20 minutes. All belts were tested on a hanging weight stand having a 3½-inch sheave operating at 3600 rpm. The belts were loaded with 85 pounds and run at an ambient room temperature of 100 ± 3°F.

V-belt adhesion and cord strength data were obtained from dissected belts. The belt jacket and top rubber were removed to expose the cord line. Alternate cords were then removed for tensile property measurements. The remaining cords were stripped individually from the belt carcass in an Instron tester.



Technicians of the Industrial Products Research Laboratory tested V-belts under a controlled dead weight at given speeds and temperatures.

Commercial V-belt cord adhesion and belt performance clearly established the requirement for a new Dacron adhesive system. Figures 1 and 2 illustrate the effect of RFL dips upon Dacron adhesion and cord fatigue. From Figure 1 it can be seen that the Dacron adhesion is less than that of rayon and remains so throughout the testing period.

This lower level of adhesion is unsatisfactory because of the resulting greater initial rate and extent of cord strength loss as shown in Figure 2 where the cord per cent strength loss is plotted as a function of the test duration.

The water-based adhesive (D-15), reported on previously, contains Hylene MP, Aerosol OT, Gen-Tac latex and sodium alginate in the following formulation:

Ingredient	*Proportions By Weight*
Hylene MP powder	100
Gen-Tac latex (40% solids)	286
Aerosol OT	8
Sodium Alginate	11
Water	743

Hylene MP is a phenol blocked diphenylmethane diisocyanate that forms the Dacron-to-latex bond. The Hylene particles are wet out by the surfacant Aerosol OT. The Gen-Tac component is a butadiene/vinyl-pyridine/styrene latex that bonds to the skim stock during vulcanization. The sodium alginate acts as a dispersant and thickener.

Adhesive Nonflammable

D-15 is a white, viscous fluid with a mild odor of vinyl-pyridine latex. In a solids content range of 20 per cent to 30 per cent it has a density of 8.3 pounds per gallon and a pH of 9.5. The adhesive is nonflammable and low in toxicity and corrosiveness.

D-15 is prepared by dissolving the Aerosol OT in water and adding the Hylene MP with mild stirring. Sodium alginate is then combined slowly with continued mixing until it is completely dissolved. Inclusion of the Gen-Tac latex completes the preparation of the dip.

Aging of the dip prior to application is unnecessary. The D-15 mixture has a pot life of at least one month in a closed container. Dipped cord shelf life tests have shown no adhesion loss after two months of storage in polyethylene bags. Open air storage reduces the shelf life to about one week.

The adhesive system, containing phenol blocked-isocyanate, is designed to regenerate the isocyanate by liberating phenol at a cord treating temperature of 390° to 428°F. Water vapor released during cord treating contains about four per cent phenol or one pound of phenol for each 100 pounds of cord dipped at a five per cent loading level. The release of the blocking agent necessitates the provision of adequate ventilation to keep the phenol content below the toxic limit.

During the initial evaluation of the D-15 adhesive, it was found that a preliminary dipping operation was required to produce a stiff cord which would not fray during belt cutting. Use of a predip not only reduced cord fray, but also offered additional improvement in cord adhesion.

Further work in this area showed that a ball-milled predip, applied in the auxiliary tank, facilitated penetration which minimized cord fray and substantially improved adhesion. The predip, ball milled for 24 hours, contained Hylene MP, Aerosol OT and water in the same proportions as the D-15 dip formulation. The following adhesion data was obtained on ball milled predip tests:

	Strip Adhesion (lbs/end)	
Sample	*W/O Pre-Dip*	*B-M Pre-Dip*
1	13.0	19.4
2	13.1	20.6
3	15.4	20.8
4	13.5	20.1
Avg.	13.7	20.2

The parameters of dip pickup, oven exposure time and oven temperature were studied to establish cord treating conditions. Dip pickup levels (Figure 3) were tested over a range of 1.0 per cent to 5.5 per cent by varying the quetsch roll pressure in the main tank of the Kidde machine. Maximum cord adhesion was obtained at three per cent pickup and appeared to be insensitive to minor variations.

To determine the optimum time-temperature relationships for producing 11,000 denier cord with both good adhesion and tensile properties, a temperature range of 420° to 450° F. and exposure time of 0.5 to 2.5 minutes were studied. The results, plotted in Figure 4, show that the highest level of adhesion was obtained in the range of 420° to 435° and one to two minutes exposure time which coincides with the best cord treating conditions for maximum tensile properties. Minor variations in Kidde time and/or temperature only moderately affect adhesion of the cord.

A statistical analysis of these data provided a time-temperature contour plot (Figure 5) of the safe Kidde operating conditions for maximum adhesion. The optimum cord treating conditions were determined to be 428°F. and 1.25 minutes exposure time, as found from the center point of the plot. Constructions varying considerably from 11,000 denier would require different cord treating conditions.

Evaluation Undertaken

Having established the required cord treating conditions, an evaluation of the D-15 adhesive in V-belts was undertaken. Kidde dip-stretched cords were built into standard B-46 belts using SBR cushion stock since the adhesive was intended primarily for use with this synthetic elastomer. The belts were tested on the hanging weight stand under the conditions previously described.

The performance of these, as measured by adhesion and cord fatigue, was compared with the performance of the commercial V-belts depicted earlier in Figures 1 and 2. The Dacron belts prepared from the new adhesive out-performed the commercial belts prepared with an RFL adhesive. The D-15 dipped Dacron cord had a strength loss, after 500 test hours, of only ten per cent compared with a loss of 53 per cent for the RFL treated Dacron and 39 per cent for rayon.

Cords from Dacron treated with D-15 adhesive (Figure 6) exhibited belt adhesion equal to that of the commercial rayon belt. The effect of this improved Dacron-to-rubber adhesion is shown in Figure 7 where the rate and extent of cord strength loss is significantly lower for D-15 treated cord than for either the rayon or Dacron items treated with RFL dip.

The D-15 formulation, with sodium alginate as the thickener and dispersing agent, has viscosity of 2800 to 3200 centipoises. The substitution of Marasperse CB, a partially desulfonated sodium lignosulfate, for the sodium alginate retains the adhesive properties while producing a dip of 20 to 50 centipoise viscosity (see table on next page). the Marasperse modification, because of its low viscosity, offers considerable advantage in dip preparation and machine cleanliness.

FIGURE 1 - V-BELT ADHESION WITH RFL DIP

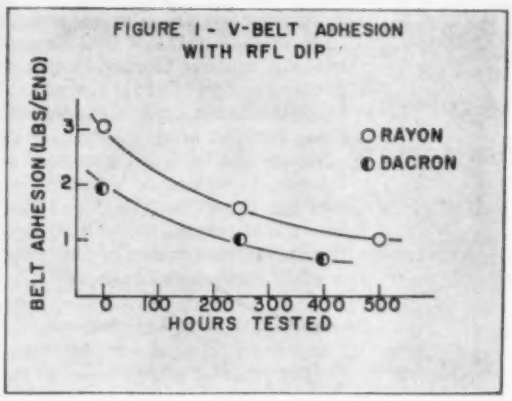


FIGURE 2 - V-BELT ADHESION WITH RFL DIP

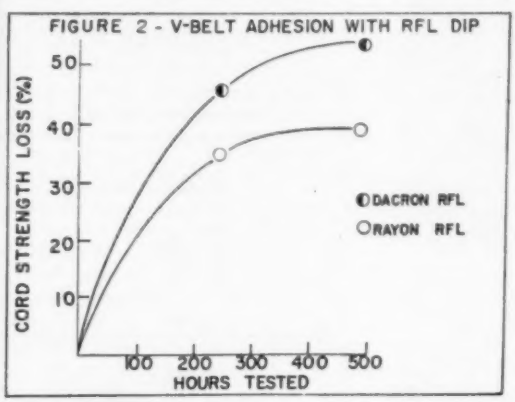


FIGURE 3 - EFFECT OF DIP PICK-UP ON CORD ADHESION

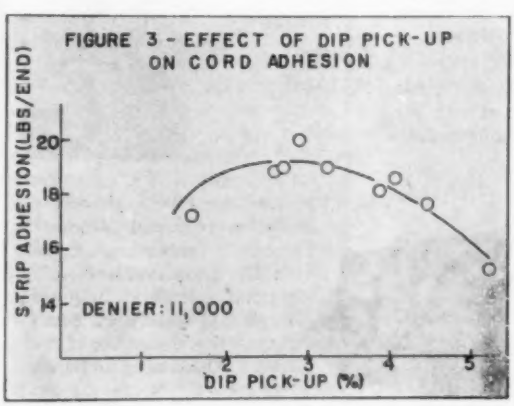


FIGURE 4 - TIME-TEMPERATURE RELATIONSHIP OF D-15 ADHESIVE

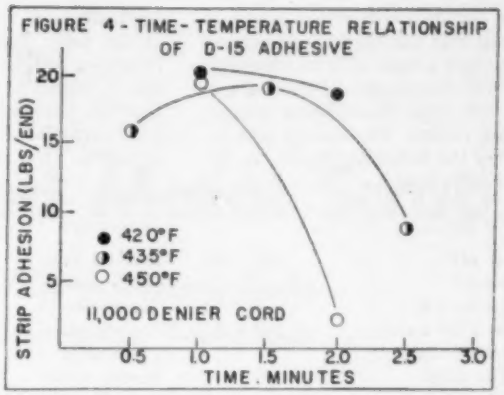


FIGURE 5 - REGION OF MAXIMUM ADHESION D-15 "DACRON" ADHESIVE

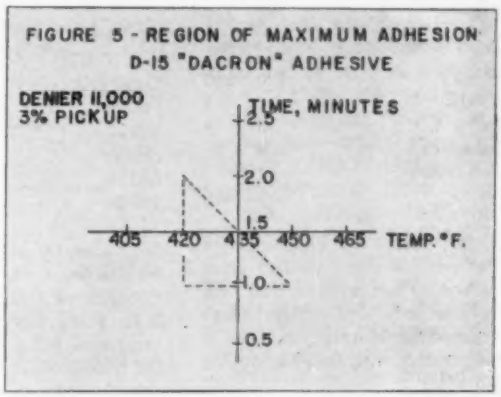


FIGURE 6 - V-BELT ADHESION

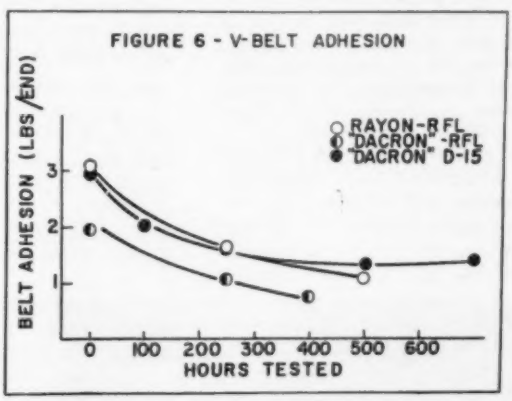
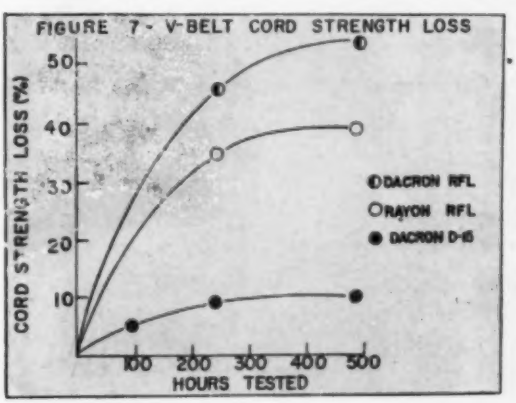


FIGURE 7 - V-BELT CORD STRENGTH LOSS



The use of a ball-milled predip is essential with the Marasperse version to maintain a high level of adhesion. D-15 with Marasperse is a more versatile dip than the original sodium alginate version. This can be seen by studying the following figures on D-15 modifications:

Natural Rubber		
Hylene MP	100	100
Aerosol OT	1	1
Marasperse CB	3	3
Pliolite 2104 Latex (58-60% solids)	340	—
Gen-Tac Latex (40% solids)	500	—
Water	776	776
Marasperse		
Hylene MP	100	100
Aerosol OT	1	1
Marasperse CB	3	3
Gen-Tac Latex (40% solids)	800	—
Water	696	696

The substitution of Pliolite 2104 latex for part of the Gen-Tac gives an adhesive for use with natural rubber. This is only one of the many extensions of the Marasperse formula which is possible with the substitution of various latices.

It is well known that the adhesive bond between cords and rubber depends upon the rubber formulation rather than upon basic elastomer. This is demonstrated in the stock selectivity given below:

Stock Formulation	*Strip Adhesion (lbs/end)*
SBR No. 1	7.0
SBR No. 2	1.2
CR No. 1	8.1
CR No. 2	1.4

The data discloses that the adhesion level of D-15 dipped cords varies markedly with different formulations of the same basic elastomer. A cooperative program with the Elastomer Chemicals Department of the DuPont Company developed three SBR formulations which yield good adhesion. They are given here:

	Formulations		
Ingredients	*1*	*2*	*3*
Smoked Sheet	15	15	15
GR-S-1500	85	85	85
Thermoflex A	1	0.5	0.5
Neozone D	0.5	—	—
Neozone A	—	2	2
Stearic Acid	2	2	2
FEF Black	30	25	30
MT Black	55	66.5	—
FT Black	—	—	55
Zinc Oxide	5	5	3
Light Process Oil	10	10	10
Paraflux	5	5	5
MBTS	1	1	1
DPG	—	0.5	0.5
DOTG	—	0.5	0.5
Sulfur	2	2.25	2.25

During the screening of these formulations, it was found that the substitution of equal parts by weight of high silica fillers for carbon black improved adhesion. The use of pine tar plasticizer, on the other hand, reduced adhesion. A neoprene formulation was also developed that showed equally good adhesion. This formulation is given here:

Neoprene GN-A	100
Thermoflex A	1
Maglite D	5
SRF Carbon Black	25
Barytes	100
Paraflux	15
Zinc Oxide	1
Durez 12707	3

In neoprene formulations, the use of zinc oxide in excess of one per cent and/or the presence of Neozone A lowers adhesion. These formulations have been evaluated only for their compatibility with D-15 and should be characterized completely before being incorporated into industrial applications.

The need for a new Dacron-to-rubber adhesive was demonstrated by the failure of RFL dip to produce good adhesion and low cord strength loss. An aqueous blocked-isocyanate adhesive system (D-15), evaluated at the best Dacron cord treating conditions, met this need, exhibiting good adhesion and low cord strength loss. Further, a commercial V-belt evaluation has shown that D-15 is an adhesive that permits the utilization of the desirable properties of Dacron as a V-belt reinforcing fiber.

Adhesion with Marasperse CB and 11000 Denier Cord

Item	*Adhesive Viscosity (Centipoise)*	*Strip Adhesion (lbs/end) Unmilled Pre-Dip*	*Strip Adhesion (lbs/end) Ball-Milled Pre-Dip*
Marasperse CB (Ball-Milled)	20-50	4.1	18.9
Marasprese CB (Unmilled)	20-50	1.9	15.4
Sodium Alginate	2800-3200	13.5	18.5

Literature References

(1) Thompson, W. L.; Marshall, T. B.; Sweet, A. T. *Adhesives Age*, Vol. 2, No. 2, 30-33 (1959)

(2) "D-15—A Water-Base Adhesive for Dacron Polyester Fiber," published by E. I. du Pont de Nemours & Co., Inc., Sept., 1957.

Note: The following materials discussed in this article are trademarked products: Dacron, Hylene, Neozone and Thermoflex (E. I. du Pont de Nemours & Co., Inc.); Aerosol (American Cyanamid Co.); Gen-Tac (General Tire & Rubber Co.); Marasperse (Marathon Corp.); Pliolite (Goodyear Tire & Rubber Co.); Paraflux (C. P. Hall Co.).

About the Author . . .

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Tooling Molds from

Adhesive Bonded Metal Scrap

Annual Savings of $20,000 in Tooling Costs Result from Unique Adhesives Technique

By using structural metal-to-metal adhesives to salvage scrap tooling metal previously discarded, Ryan Aeronautical Co., San Diego, Calif., is saving upwards of $20,000 annually in tooling costs. This money-saving application of aircraft adhesives evolved from the solution to an emergency production problem.

About a year ago, the company was called upon to produce molded fiberglass shells for wing-tip radomes on its Firebee drone targets. Early dates for quantity delivery specified in Air Force and Navy contracts made for extremely tight production schedules.

"We needed a four-foot-long male mold," explains Ted Grabowsky, industrial engineer of Ryan's Tool Fabrication Division. "Investigation revealed that aluminum castings and patterns would cost about $600, and that we could not expect delivery in less than six weeks."

Alternative Method Evolved

As an alternative, Ryan engineers conceived the idea of building the tooling mold by following a procedure similar to that in which wood blocks are glued together to build up a forming block. In this application, however, scrap pieces of cast aluminum tooling metal were bonded together with a structural aircraft adhesive, Narmco Metlbond 4041.

The result: within ten days, Ryan not only had a workable mold, but it had produced the first Firebee radome.

The success of this initial tooling application of structural adhesives led to further experiments, and the salvaging of scrap aluminum tooling metal was expanded through the use of similar techniques. For example, scrap tooling metal previously considered waste was now rough sawed and adhesive bonded to form blocks of required sizes. These blocks were then machined to the size and configuration of the desired tools.

In the past, some salvaging of small scraps of tooling metal had been accomplished by building up blocks with dowel pins and bolts. Awkward and time-consuming, this method necessitated the plugging of dowel and bolt holes to prevent the scarring of manufactured components.

In the new procedure for bonding the blocks, metal surfaces are first prepared by being cleansed with a methyl-ethyl-ketone wipe. This is followed by an alkaline cleansing and a water rinse.

After drying, faying surfaces are primed with Metlbond 4041, Type 11, to 0.005" thickness, and permitted to air-dry at room temperature for 60 minutes. Metlbond tape is then interposed between the primed faying surfaces, and the assembly is subjected to a cure cycle of 350°F. at 100 psi for 60 minutes.

An elastomer modified phenolic in unsupported film form, plus a liquid metal prime, Metlbond 4041 is manufactured by Narmco Resins & Coating Co., Costa Mesa, Calif. It is one of the company's many adhesives finding wide application in the missile and aircraft industry.

According to Ryan engineers, strength characteristics of the adhesive bond are outstanding. In tests on the laminated blocks of tooling stock, a bond has never been torn apart, regardless of the severity of the cut during machining, Ryan engineers state.

"Projecting potential economies on the basis of our record so far," Grabowsky reports, "we estimate a savings of approximately $20,000 a year." The company's adhesives costs for the same period will be approximately $200.

With this success in the use of structural adhesives in metal salvaging, Ryan's Tool Fabrication Division is continuing to explore other possible applications for structural adhesives.

A tooling ring is machined from a laminated block of scrap tooling metal. The adhesive bonds between the metal blocks are unaffected by the machining.

STAFF REPORT

Adhesives *Make* the

Since 1953 the Chevrolet Motor Division of General Motors has been using an adhesive to bond the fiber glass bodies of the Corvette sports car into an integral unit. This departure from the use of nuts, bolts and spot welds in automobile assembly line operations was predicated upon a decision to construct the Corvette using a light-weight glass fiber reinforced body in order to obtain a high horsepower-to-weight ratio. Fiber glass is a completely inert material which will not rust, oxidate, discolor, rot or deteriorate. Adhesives presented themselves as perhaps the only means by which the fiber glass parts could be bonded together. Moreover, adhesives provided a bond stronger than the fiber glass itself.

With one of five engines, ranging from 230 to 290 horsepower, under the hood, the Corvette's body must have inherent strength to go along with its light weight. Corvette owners put their sports cars through the trying paces of long overland trips, speed events and time trials. High operating performance and durability from all Corvette equipment, be it fiber glass or metal, is a must for the hard driving that the sports car is called upon to make.

A two-stage polyester resin-base adhesive is the bonding agent which forms the fiber glass body parts of the Corvette into an unbreakable unit. The adhesive, which is applied on the Corvette body build-up assembly and sub-assembly line, is prepared in the assembly area and made up in two batches: a hot bond mix and a cold bond mix.

The batches, mixed separately in two 1/3 cubic yard capacity cement mixers and prepared under and for use at a normal temperature of about 70°F., contain, in the hot bond, 25 gallons of resin (Vibrin 151), 40 pounds of accelerator (ATC) and 115 pounds of asbestos filler.

The cold bond batch contains 25 gallons of resin, 5 gallons of catalyst (Promoter 400) and 115 pounds of asbestos filler. During the work day, four batches of each bond are mixed and distributed in separate containers to the lay-up stations on the body build-up line.

If the room temperature is high enough to affect the setting time of the adhesive, a smaller quantity of the hot bond is mixed, and conversely, if the temperature is below normal, a larger quantity of the hot bond is prepared. The operator determines the quantity of the batches thus facilitating the assemblers' mixing operation to a simple one-to-one mixture of the hot and cold bond in the amounts needed.

The selection of the most suitable adhesive for bonding the Corvette's fiber glass body was reached after extensive ingredient testing by the General Motors engineering staff. In addition to the resin and mineral filler, certain catalysts and low temperature cure ingredients were needed. Chevrolet first adopted cobalt, 2,2' dihydroxy 5,5' dichlorodiphenylmethane (DDM) and ATC as the materials to be used. The first Corvettes were built in Flint, Mich.,

and these materials proved satisfactory on a low production basis.

In late 1954, the production of the Corvette was moved to the Chevrolet plant in St. Louis, Mo. Since DDM is highly explosive, a search was made for a less dangerous material with which to work and at the same time accomplish the desired operating characteristics.

Several factors were beginning to play a part in the desire for new adhesives components. First, there was no flexibility in the mixing of resin and DDM which meant that virtually no pot life could be achieved. In operation, the resin, mineral filler and DDM were mixed together and the cobalt was added later to begin the reaction.

If the mix was prepared by mixing the resin, cobalt and mineral filler, later adding to DDM to start the reaction, a problem of skimming over occurred. In this case, an inhibitor had to be added to the mix to keep the skimming over from taking place. In addition, the cure time of the mix when catalyzed at low temperatures was not as fast as desired by production line technicians.

Service Repair Kit

Another factor in the quest for suitable adhesives components was the preparation of a Corvette Service Repair Kit for plastic body repair work in the field. The deterring factor here was the problem involved in shipping the DDM and cobalt.

In the course of testing and experimentation, the engineering staff tried ATC and Promoter 400 and found these materials to be safer than the ones being used. Aside from the all-important safety factor, it also was discovered that the ATC and Promoter 400 would meet the necessary requirements for catalyzing the resin and mineral filler.

The two new materials were first used in the Service Repair Kit and when they proved to be satisfactory, they were used in the St. Louis plant in bond mixing with favorable results.

Additional research by the engineering staff and the St. Louis plant found that if resin, mineral filler and ATC were mixed together in any quantity, they were stable for a period of at least 48 hours as long as there were no abnormal changes in temperature. For example, at temperatures of 70-80°F., resin and ATC could be premixed without gelling taking place over a 48 hour period. The mineral filler being used could then be added at a later time when the mix was ready to be used in production.

Another method of preparing the ingredients was tried by mixing the resin, mineral filler and Promoter 400 together. The ATC was added later to start the reaction. It was this method that was adopted and is presently being used at the St. Louis plant, since it was found that the mix would be stable for an indefinite period of time.

Shelf life as well as production schedules determine the amounts of adhesive materials kept on hand at the St. Louis plant. The resin and ATC have a shelf life of about 90 days while the Promoter 400's shelf life is indefinite.

It takes 40 pounds of adhesive to bond together a single Corvette, or 1,800 pounds in a single day's production of 45 units.

It takes 40 pounds of the adhesive to bond together the fiber glass Corvette body which amounts to a daily usage of about 1,800 pounds of adhesive in bonding a day's production of 45 Corvettes. Each assembler on the body build-up line mixes the hot and cold batches in a small beaker in the quantity needed to perform his specific build-up operation.

Once the hot and cold components have been mixed together and poured into a paper, cone-shaped applicator, the mixture must be applied to the surface to be adhered, and the mating part clamped in position before the adhesive mixture sets—about six minutes under normal temperature conditions.

Prior to reaching the body build-up line, the molded fiber glass parts travel on an overhead conveyor through a shot blast booth where portions of the parts are "roughed up" by steel shot fired at them with compressed air. This physical roughing of the fiber glass provides a gripping surface for the adhesive, and care must be exercised not to let stray shot hit areas that require finishing and painting. From the shot blast booth, the treated parts are then distributed to their positions along the assembly line.

The body build-up operation begins with work on the fiber glass underbody. After body bolt reinforcements are attached to the underside of the underbody, the part is transferred to the body build-up truck for its trip along the assembly line. A master body build-up fixture is clamped in position across the underbody which serves to hold the body shape. It also serves as a guide and stabilizer for additional supports.

After aluminum reinforcements are attached to the underbody, the exhaust tailpipe duct and gas tank bulkhead are bonded and clamped to the underbody. As the build-up fixture moves along the line, assemblers mix up specific quantities of the adhesive, apply it to the applicable areas and put the mating parts together, clamping them in a solid, immovable position until the bond sets.

All Parts Coated

All along the body build-up line fiber glass parts are given an adhesive coating. In continuing the assembling operation, the rear upper panel is bonded to the underbody and the already bonded gas tank bulkhead. Next, hinge pillars are bonded to the underbody and the firewall extension (dashboard) is bonded to the toe panel of the underbody.

At the next station, the front fender skirt is bonded in place while the front top panel is bonded to the grill opening panel in a sub-assembly operation. When this sub-assembly bond is complete, the part is bonded to the hinge pillars, firewall extension and fender skirts. Next the rocker panel is bonded to the underbody, the hinge pillars, the front top panel and the rear top panel.

From this point, small sub-assembly bonded and individual parts are placed into position on the practically built-up body. Small parts are bonded into position and in many cases,

Building the Corvette Body with Adhesives—Step-by-Step

FIG. 1—Operator adding accelerator to cold mix in one-third cubic yard capacity cement mixer.

FIG. 2—Assembler pouring the mixed adhesive into a disposable cone (poke) applicator.

FIG. 3—Shot blast bonding removes glaze and provides a rough surface for bond adhesion.

FIG. 4—Setting the gas tank bulkhead onto the adhesive coated underbody.

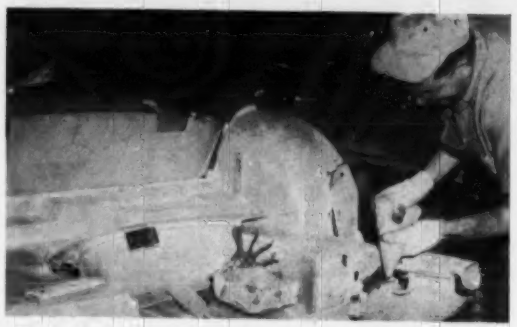


FIG. 5—Assembler applying the adhesive to rear of underbody in preparation for rear end assembly operations.

FIG. 6—The rear top being set in position on the adhesive coated underbody.

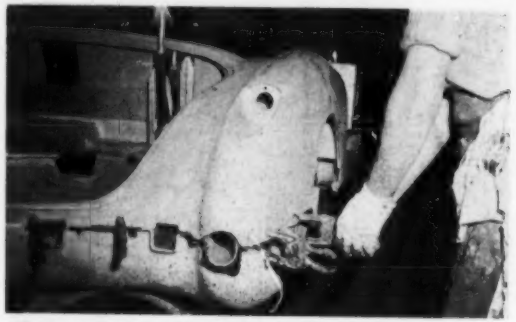


FIG. 7—Assembler clamping the rear top to the underbody in order to insure a secure bond.

FIG. 8—Applying the adhesive to a rocker panel prior to bonding it to the front top panel.

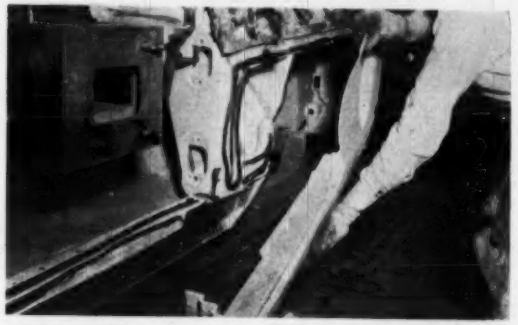


FIG. 9—Placing a fender skirt into position on the adhesive coated front top panel.

order to insure a secure bond.

ing it to the front top panel.

coated front top panel.

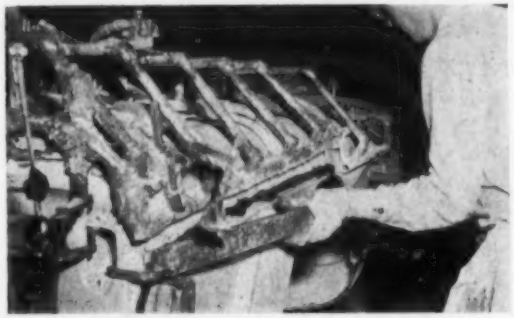


FIG. 10—Assembler clamping on a joint back-up bar to maintain body shape while adhesive is setting.

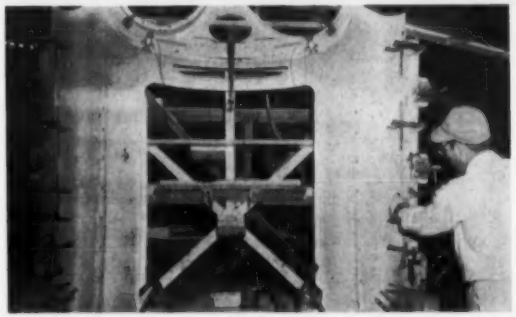


FIG. 11—Clamping a front top panel to grill opening panel in a sub-assembly operation.

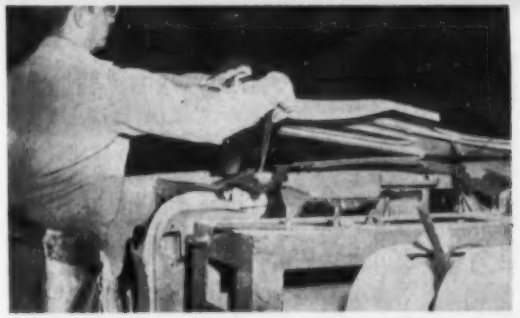


FIG. 12—Front top assembly being placed on the adhesive coated underbody.

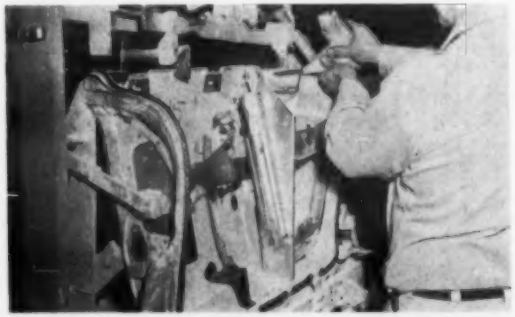


FIG. 13—Applying the adhesive to the inner door panel—a sub-assembly operation.

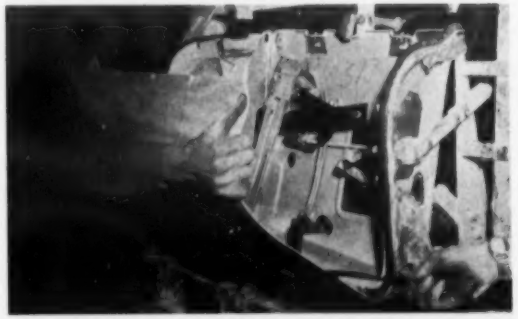


FIG. 14—Placing the outer door panel onto the adhesive coated inner door panel.

FIG. 15—Sander building up a low area on the fiber glass door.

FIG. 16—Adhesive being used to make minor touch-ups on the front end.

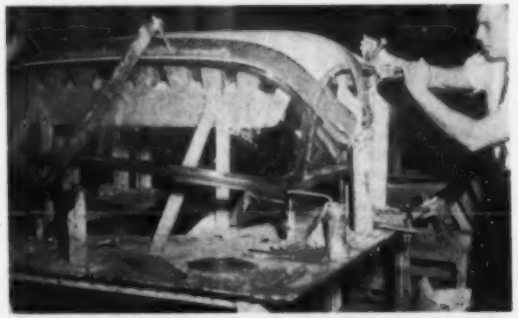


FIG. 17—Clamping the hard top assembly fixture into place —a sub-assembly operation.

FIG. 18—The finished 1959 Chevrolet Corvette, ready to travel the highways.

where connecting screws are used, they are given an adhesive coating.

The body then passes into a grinding booth where the excess bond is ground down to conform with the contour of the body which is also ground to improve contour. In the grinding booth the doors are installed onto the body. The door assembly is done adjacent to the grinding booth and consists of putting into the inner door the handle and window mechanisms, and then bonding the outer door to the inner door.

The body leaves the grinding booth and enters a repair area where defects in the fiber glass are repaired. Damaged areas are cut out and built-up by bonding a fiber glass cloth over the cut out area, adding the adhesive to the cloth to build-up the area. After it is set, it is ground to conform. The adhesive also is used to fill in ground down bonded seams where pinholes occur, and to build-up areas where defects have been ground out.

From this point, the bonded fiber glass body continues on its way towards complete assembly by passing through such usual automobile manufacturing operations as: dry sand booths; prime spray booth; prime ovens; paint spray booth; refinish ovens; refinish spray booth; paint oven; buffing booth; trim and accessory line; body drop to chassis line; final assembly line; water test booth; repair area; repair spray booth; infrared oven; and the polish booth, producing the finished Corvette.

Since the Corvette was first produced in 1953, there have been no reports of bond failure. During manufacture, bonded joints are given periodic daily checks during the body build-up operation to make certain that temperature or humidity or improper mixture have not weakened the bond strength of the adhesive itself.

Note: The materials mentioned in this article are produced by the following companies: Vibrin 151—Naugatuck Chemical Division, U. S. Rubber Co., Naugatuck, Conn.; Promoter 400—American Cyanamid Co., Bound Brook, N.J.; ATC—Lucidol Co., Division of Wallace & Tiernan, Buffalo, N.Y.; Molded Fiber Glass Parts—Molded Fiber Glass Body Co., Ashtabula, Ohio.

Adhesive bonding of Laboratory Equipment

Because of the precise nature of its demands, the assembling of experimental apparatus for chemistry laboratories often poses complicated bonding problems. Not only must the adhesive used be able to form a perfect bond—often between unusual or unfamiliar materials—but it must have nothing in its own chemical composition capable of influencing or distorting the material or the reaction being studied.

For example, at Florida State University chemists charged with building equipment capable of continuously measuring the activity of an atmosphere composed partially of carbon-14 monoxide ran into an assembly difficulty. Because of the low energy of the carbon-14 beta particle, a thin window of some sort had to be bonded to the cell of the containing apparatus so that the beta particles could pass out and be detected.

It was decided that the window could best be formed by a thin sheet of aluminum foil which would cover an aperture in the Pyrex cell. The use of an adhesive was obviously called for—but which?

Project technicians realized that not only did the adhesive chosen have to be capable of forming a satisfactory bond between the aluminum window and the Pyrex vessel, but it had to be of a chemical nature which was inert so far as the materials used in the instrument itself were concerned. These included benzene, carbon monoxide and various metal carbonyls.

The problem was further complicated by the fact that the adhesive had to be easily removable so that the windows might be replaced as needed. This proved to be a major stumbling block with many of the adhesives tested.

After some experimentation, Florida State chemists found that Bondmaster M620, made by Rubber & Asbestos Corp., fit the bill on both counts. It was not only inert to the chemicals used in the instrument's test cell, but could be easily burnt off at the annealing temperature of Pyrex.

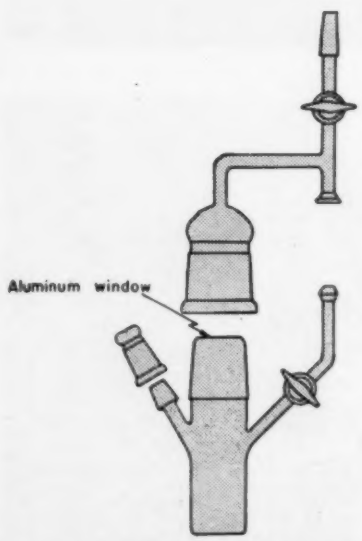
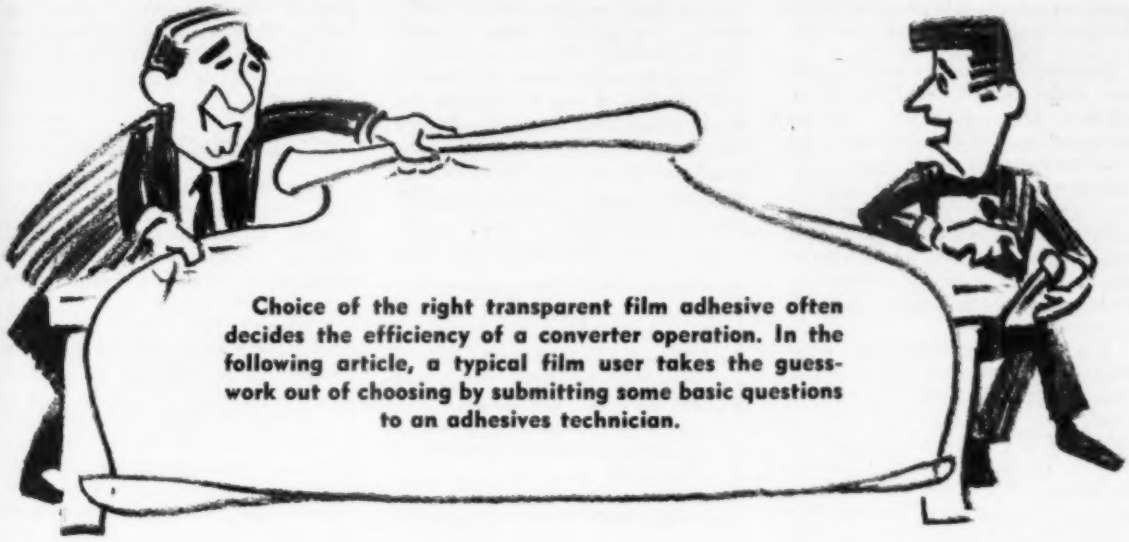


Diagram of chemical laboratory's measuring apparatus shows position of aluminum foil window.

Adhesives for Transparent Films



Choice of the right transparent film adhesive often decides the efficiency of a converter operation. In the following article, a typical film user takes the guesswork out of choosing by submitting some basic questions to an adhesives technician.

By HARVEY MILLER
Technical Department
Morningstar-Paisley, Inc.
Chicago, Ill.

Question: There are many types of transparent films and many different products in which we can use them. How can we, as converters, possibly select proper adhesives for all of them?

Answer: That job should be left to your adhesive supplier. He has the know-how to select correct adhesives based on the type of film, the gluing machine, the surface the film will be adhered to, and such other factors as aging performance, low temperature characteristics, etc.

To help him make the best possible recommendation for your operation, you should supply him with as much information as possible. (1) Tell him what film grade, and gauge you will be using; (2) what surface you intend to adhere it to; (3) what machine you will run it on; (4) if the glue pot or wheels are made of brass; (5) what special conditions your package must withstand; (6) what will the expected life of your package be. All of this is important.

Your adhesive supplier could give you a good recommendation with answers to the first three questions only; but the more you tell him, the more the adhesive will be suited exactly to your needs.

Question: If you use many different films, doesn't that usually mean a big inventory of different grades of adhesive? Isn't it possible to get one adhesive for all these films? After all, they are all plastics.

Answer: We will answer that question in its reverse order. First, although most transparent films could be considered as plastics, it doesn't follow that there is one adhesive that is an all-purpose "plastic glue." Different films have diffrent chemical compositions, and it is the chemistry of the surface that determines the type of adhesive that you can use.

For example, adhering treated and untreated polyethylene are two very different adhesive problems. Untreated polyethylene presents a surface of relatively saturated or "satisfied" carbon atoms. They are so satisfied that they are not too interested in linking up with any adhesive molecules that may come near them.

On the other hand, the oxygen atom is a greedy cuss and even though he is holding on to what might be considered his limit, he is always willing to hang onto just a little extra. By oxidizing the surface of polyethylene, enough surface oxygen atoms are made available to allow adhesion. This is a very simplified explanation of why treated polyethylene is much easier to adhere than untreated film.

As to the possibility of an all-purpose adhesive for plastic films, several adhesive firms are working toward this with some success. At Morningstar-Paisley, for example, adhesives are supplied which will work on both moistureproof cellophane and cellulose acetate; on Mylar and cellulose acetate; on polyethylene, Pliofilm, Saran, and some vinyls, etc.

Other factors must be taken into account, however, and we have over ten grades just for moistureproof cellophanes, depending on the operation. Grades are available for window patches on boxboard and paper bags; seam and bottom glues for all-transparent bags; laminations; combination or panel bags; heat seal activators, etc. However, any given converter has only a limited number of operations and by helping him to select proper adhesive grades, the supplier can generally cut down on the number he needs to stock. When an unusual job requiring a special glue comes in, he can order a sufficient amount for his particular needs.

Question: Generally, moisture-proof cellophane and cellulose acetate type films use polyvinyl acetate emulsion adhesives, while other types use latex glues. Why is this?

Answer: This goes back to the surface chemistry of the films themselves. The polyvinyl acetate molecule has specific adhesion to the cellulose molecule and generally poor adhesion to such molecules as polyvinyl chloride (vinyl), polyethylene, rubber hydrochloride (pliofilm), etc. In the latter cases, we would have to go to "latex" adhesive molecules, such as butadiene-styrene (GR-S), acrylonitrile, etc.

It goes a bit deeper than this, however. It is almost an absolute rule that in order to adhere a surface you must "wet" it. By the term "wet" we mean giving over-all intimate contact between the surface and the adhesive molecules. When we have perfect over-all contact, we have perfect wetting. Partial contact gives us only partial wetting. A perfectly wetted surface is perfectly adhered, providing it stays perfectly wet.

For example, adhesives based on polyvinyl acetate have introduced into them substances which may either increase or decrease its wettability onto a surface. Correctly chosen plasticizers increase wetting; some water-soluble polymers and gums decrease wetting. By chemically blending a polyvinyl acetate molecule with a different chemical group, such as an acrylic, we can wet surfaces which plain polyvinyl acetate could not do.

Polyvinyl acetate based emulsion adhesives are generally preferable because they machine better, clean up better, resist oxidation and yellowing better, and are not affected by copper or brass equipment. We are now building polyvinyl acetate type adhesives for plastic films with which latex or solvent adhesives were the only answers. The formulations are based on requirements outlined in the preceding paragraphs. It is now possible to adhere vinyl, Mylar, polyether, Saran, to name a few, with polyvinyl acetate type emulsion adhesives as well as latex emulsion adhesives.

Question: We have seen many cases where an adhesive begins by causing a fiber tearing bond, but results in complete bond failure within a comparatively short time. Why is this? Are we testing our bond in the wrong manner?

Answer: In evaluating adhesion by the above method you are confusing tack and adhesion. Tack can be considered as almost another way of saying very high viscosity. A very viscous fluid is tacky and will hold onto a surface by virtue of that quality. When it loses viscosity, either by turning solid or by thinning out, it will also lose its hold on the surface, unless the forces of adhesion take over. A pressure-sensitive adhesive holds on by tack. Since its high viscosity is fairly stable, it can hold on for a long time.

. . . A properly compounded adhesive will have both tack, for initial or quick "grab," and adhesion, for a final or permanent bond. Both must be tested to insure a proper gluing job.

For example, we can adhere untreated polyethylene to paper with a very viscous slow drying starch paste. However, as soon as the paste dries out, the polyethylene will fall off. Adhesion, on the other hand, is a chemical phenomenon and, providing no changes occur in either the surface or the adhesive, will be permanent.

A properly compounded adhesive will have both tack, for initial or quick "grab," and adhesion, for a final or permanent bond. Both must be tested to insure a proper gluing job.

Depending upon the operation, tack should be evaluated within a reasonably short time: immediately after application and in a day or two. It should be evaluated with one important point in mind. The function of tack is to hold the surfaces in close contact long enough to allow the forces of adhesion to set in. A development of fiber tear instantly is often not necessary, especially on tough undersurfaces, such as glassine, Kraft, etc. The development of legs or "fiber" is often sufficient. It must be remembered that a bond produced by tack is substantially weaker than the bond produced by chemical adhesion.

Adhesion should be evaluated when the bond produced by tack disappears. It is difficult to give a set time for this, but in the case of polyvinyl acetate adhesives, 24 to 72 hours generally is sufficient. Latex adhesives follow this pattern, except for the so-called pressure-sensitives. Here, adhesion generally never plays too strong a role and we rely on tack to hold our surfaces together for as long as they can. With solvent or lacquer adhesives, the tack is usually held as long as there is solvent still present. This can often be determined by smell.

Question: What is crystallization?

Answer: Previously, we discussed how a surface is wetted to obtain adhesion. Crystallization means that due to various factors the adhesive has lost its wettability. Result? Poor adhesion.

Crystallization as used here bears no similarity to the true definition of crystallization. When a saline solution evaporates, the salt comes out of solution in the form of crystals. This is not the phenomenon meant by the adhesive term "crystallization." In adhesive terminology, this term means loss of adhesion. The bond often yields to a firm pressure with an audible "crackling" sound, leaving the adhesive with a smooth surface. The latter is the mirror image of the surface formerly adhered.

Question: What are the various reasons for crystallization?

Answer: The most common explanation is that there never was adhesion at all. The bond exhibited was probably due solely to tack, and when the tack disappeared, the bond failed. Another important cause of crystallization is the degradation of the adhesive polymer, as a result of oxidation, ultraviolet ray exposure, bactericidal or fungicidal attack, etc. The most obvious way to avoid this is to use adhesives which are resistant to such degradation.

A saturated polymer such as polyvinyl acetate falls into this resistant category. If polymers of these types cannot be used, then such additives as antioxidants, ultraviolet absorbers, preservatives, etc., should be employed. Of course, this is the job of the adhesive supplier.

Crystallization also occurs when an adhesive polymer itself does not have good adhesion to a particular surface, but is given this by judicious compounding. Adding proper plasticizers, wetting agents, or compatible polymers would be methods of judicious compounding. Under some circumstances, these additives cause a drop in the adhesive's wetting power and poor adhesion results. This again can be avoided if the adhesive manufacturer selects proper ingredients for his compound.

This, by the way, accounts for the fact that adhesives for transparent films are more expensive than most other types. Quality film adhesives must use quality ingredients. Any "ersatz" substitution is quite likely to lower the performance of the adhesive bond.

Question: What is migration? When does it occur? Is it always harmful?

Answer: Migration is the movement of an ingredient either to or from the adhesive into the adherend. It occurs when you have an ingredient that is mobile (another term would be fluid), and where the medium into which the migration occurs is equally or more receptive to the ingredient than the medium from which it originated.

> . . . Quality film adhesives must use quality ingredients. Any "ersatz" substitution is quite likely to lower the performance of the adhesive bond.

No case comes to mind where migration is helpful. On the contrary, it can be quite serious. It reduces the adhesive's wettability somewhat and causes partial loss of adhesion, sometimes to a point where "crystallization" will occur. Migration into the adhesive weakens its cohesive strength so that it gets quite gummy and produces a weak bond.

The worst result of migration is blocking or picking. Remember, transparent films are plastics and suitably compounded with plasticizers or solvents many of them would make good adhesives. If enough plasticizer or solvent were to migrate along the adhesive line from the adhesive into the plastic, the film would itself become an adhesive. As a result, the film would be blocked to the surface above it. The responsibility of preventing this lies with the adhesive.

Question: Can the aging characteristics of adhesive bonds be predicted?

Answer: To a degree. Of course, the best way is by past experience. A company which has been selling a particular adhesive grade for a particular operation for many years, can reasonably predict its expected aging characteristics. However, there are test methods available. At Morningstar-Paisley, we have set up certain tests to accelerate the aging of adhesive bonds and to obtain an approximate idea of their performance. If unusual conditions are to be encountered—such as exposure to low or high temperature, low or high humidity, exposure to ultraviolet or other radiation, etc.—these are taken into account.

Question: What precautions should a converter take when he is using a polyvinyl acetate emulsion adhesive?

Answer: First, sanitation. Make sure your equipment is clean before running adhesive. Be very careful to avoid contaminating the adhesive with other kinds of glues; they are generally incompatible. If the adhesive manufacturer had wanted the glue mixed, he would have done it himself and supplied the mixture.

Second, dilute only in accordance with the manufacturer's instructions, if at all. Remember, water is not a glue. Too much of it cuts down on tack by cutting down on viscosity. In addition, by diluting, you cut down on adhesive solids and reduce the amount of adhesive applied to any one area. This weakens the final bond. Naturally, reputable and skillful adhesive manufacturers build a margin of safety into their glues. They give you more adhesive solids than you actually require. If they did not, your operation would be too borderline and too fraught with the dangers of failure.

> . . . Dilute only in accordance with the manufacturer's instructions . . . remember, water is not a glue, too much of it cuts down on tack by cutting down on viscosity.

Third, use an adhesive in an application for which it was intended. In case of doubt, contact your supplier. That is one of the services you are paying for when you buy glue.

Fourth, use the FIFO system of inventory: first in, first out. In other words, use the oldest glue first. Never store adhesive longer than the recommended maximum time set by the supplier. If you do have old glue of which you are in doubt, contact your supplier. He will tell you if it is safe to use.

Fifth, never run glue too cold, or use glue on film, paperboard or paper that is too cold. There is a saying that, "Cold glue is slow glue." The colder a glue is, the longer it will take to set up. Try, if possible, to keep your glue, your film and your paper or board at room temperature.

Sixth, never allow a water-based adhesive to freeze; usually it is not recoverable.

Seventh, stir before using. Emulsion glues tend to settle slowly. This means that if you did not stir you would be running at low solids near the top of the drum and extra high solids near the bottom. Neither case is good.

Question: How about precautions for running latex adhesives?

Answer: With one addition, the precautions to be taken here are the same as for resin or polyvinyl acetate emulsion adhesives. Try not to run them in copper or brass equipment. If you must do so, notify your supplier of that fact. Many latex adhesives can be stabilized against copper, some are immune to the poisonous effects of copper.

In addition, cleaning the equipment after running a latex adhesive is generally more difficult than after running a polyvinyl acetate emulsion adhesive. Solvents such as toluene or acetone are often required. We have found that for some applications, two parts of household ammonia mixed vigorously with one part of toluene is a good cleaner—if you can stand the smell! Add two parts warm water and use. Remember toluene is inflammable, so don't smoke while using this cleaning solution.

Question: How about precautions for using lacquer or solvent adhesives?

Answer: First, remember that most solvents attack rubber and other plastic surfaces. If you have rubber stencils or plastic machine parts, check with your supplier as to whether the solvents employed will affect them.

Second, since most solvents are inflammable, be careful of open flames, lighted cigarettes, electrical discharges in the area adjacent to the gluing machines. Ventilate well.

> . . . Use an adhesive in an application for which it was intended. In case of doubt, contact your supplier.

How To Select

Starches for Coating Adhesives

By CLAUDE H. FLETCHER
Corn Products Sales Company
New York, N.Y.

New developments in starches for coating adhesives now make it possible for the paper manufacturer to choose from a wide variety of products especially prepared to meet the needs of different coating operations. Industry research and development has resulted in new starch types for both on-the-paper-machine and off-the-machine operations.

These two basic coating procedures require different types of starch for use as coating binders. On-the-machine operations need a high solids coating made from starches for enzyme conversions in the coating mill. Off-the-machine procedures employ a medium solids binder for which oxidized and ethylene oxide starches are eminently suited. The latter types are also used in low solids coating applied at the machine size press.

The use of starch for high solids work in on-the-paper-machine coaters will be examined first. In this application, coating solids of from 58-63 per cent are necessary because (1) of the heavy coat weight applied, and (2) the coat weight must be properly dried after it leaves the machine coater and comes in contact with another section of driers.

Casein Formerly Used

In the past, casein was widely used as the binder in machine coatings, but most machine coated paper is now made with starch as the adhesive. Starch fulfills the requirements for a high solids adhesive in the coating slip. Because they eliminate many of the drying troubles encountered with casein binders, starch adhesives did much to aid and accelerate the machine coating process.

The starch industry today is offering highly developed products for enzyme conversion. In many respects these are tailor-made for particular conditions which may exist in a plant.

However, two basic problems remain: (1) maintaining viscosity stability of the converted starch at 30-35 per cent solids and (2) retaining efficient adhesiveness of the starch binder at these solids, so that the best possible bond between the coating and the raw stock is obtained.

A definite relationship exists between viscosity stability of the adhesive and the adhesiveness of the converted starch. Anything which overcomes or minimizes the variation in starch viscosity will also increase the efficiency of the binder. Unusual starch properties brought out by viscosity variations during conversion will be accentuated when the pigment and starch slips are mixed for machine coating at solids of 60-63 per cent.

Machine roll coaters depend heavily upon stable viscosity and uniform solids to give them a constant coat weight with the same surface characteristics in day to day production of coated papers. While to some extent this problem can be controlled mechanically, the entire coating slip formulation should be examined for possible variations in procedures which could conceivably introduce a variable into the coating slip preparation.

Variables in coat weight and machine performances may be traced back to either the adhesive or pigment slip. Factors within the mill may be contributing to a discrepancy in performance.

For example, the starch used must be completely compatible with the mill water during the liquefying cycle. Any deviation can be a contribu-

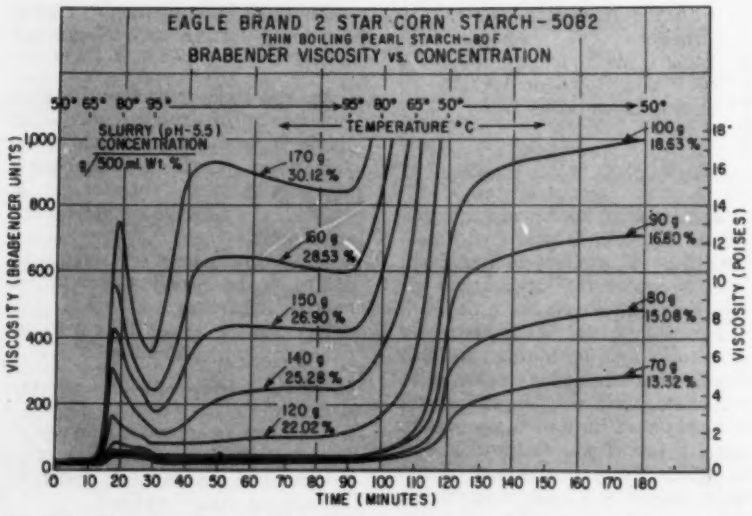


FIG. 1—Brabender amylograph indicates the viscosity and congealing tendencies of acid modified starch after the adhesive has been cooked.

ting factor in viscosity variations that adversely affect adhesive stability and bonding strength.

The starch industry is prepared to offer technical assistance in evaluating mill water and recommending a particular enzyme conversion starch with appropriate buffering action blended in during the manufacturing process. Once the correct starch has been established, the cooking equipment and conversion cycle should be examined.

Cooking equipment may be of stainless steel, wood or coated steel. Copper or copper-lined tanks should never be used as they will inactivate the enzyme units. Agitation in the cooker should be ample but not turbulent, and should continue at a steady level through the gelation period.

The over-all stability of the adhesive will be much better if the conversion holding period—usually 15 to 30 minutes—is used for determining the viscosity, rather than resorting to an overdose of enzyme and a short conversion period. The best possible conversion is the lowest possible viscosity for the particular coating setup, with the lowest possible percentage of sugars. The presence of the latter is not desirable from an adhesive standpoint.

The action of the starch liquefying enzyme is not selective and if conversion is not cut off at the proper point the starch will be converted into extremely small particles. These will not deliver maximum performance from the standpoint of either viscosity or adhesiveness.

Final Step in Cycle

The final step of the conversion cycle is to heat the starch water solution to 200°F. to inactivate the enzyme so that it will not thin out the starch to a lower viscosity than desired. The starch adhesive is then cooled to the desired temperature for mixing with the clay portion of the coating formulation.

Coating paper on either a brush or roll coater away from the paper machine has been an established industry for years. Here too, for many years casein was considered the standard adhesive for this work. Recently, however, starch has come into wide use as a conversion coating binder.

In this coating, starch is not equal to casein in adhesive strength, but it does have advantages in that it is odorless and does not form foamy coating color. Where real water resistance is not necessary, starch pigmented coatings have printability and machine performance generally equal to the casein sized coatings.

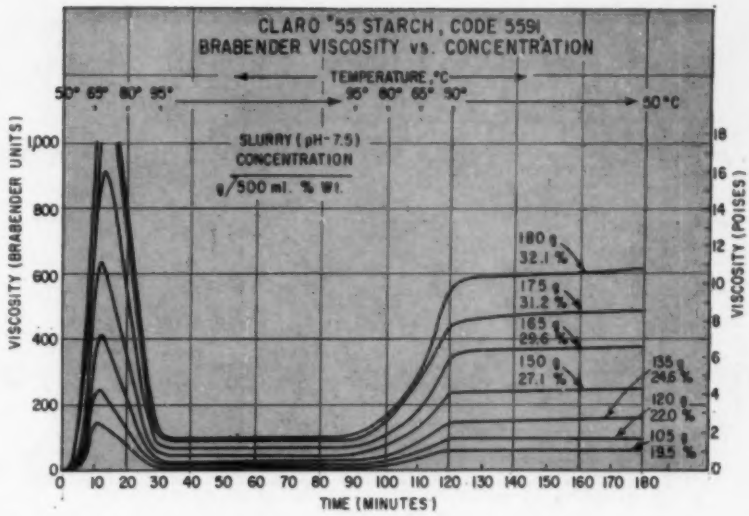


FIG. 2—Brabender amylograph indicates the viscosity and congealing tendencies of oxidized starch after the adhesive has been cooked.

Because of the medium solids range—35-50 per cent—of the coating, the starch adhesive does not have to be modified as thoroughly as in higher density work. In this application, it is generally felt that a different type of starch is necessary—one in which the full adhesive strength is present at lower solids.

The starch should retain good flow properties. At the same time, it should possess sufficient body or water holding properties so that neither viscosity stability nor adhesiveness in the coating operation is sacrificed.

The adhesive must impart sufficient fluidity to the coating so that it can be smoothed out on the sheet by the coating applicator. However, it should not have so much fluidity that the rawstock is soaked or so that drying operations are adversely affected.

Oxidation starches used for conversion coating are especially modified in the starch plant to possess these characteristics. They are manufactured in a full viscosity range from very heavy to very fluid.

Readily mixed with a pigmented slip, oxidized products possess protective coloid qualities which hold the pigment in suspension. However, their outstanding quality is their viscosity stability in the coating slip which makes this starch type compatible in the coating color.

The Brabender amylographs in Figures 1 and 2 indicate the different behavior of the regular thin boiling and oxidation modifications, with respect to viscosity and congealing tendencies. Of extreme importance to the coating industry is the lack of viscosity change shown for the oxidized starch, after the adhesive has been cooked.

Whereas the regular acid modified Grade 5082 (Figure 1) shows an enormous thickening after the cooked paste is cooled, the oxidized 5591 (Figure 2) shows very little change at this point in the adhesive preparation cycle. The viscosity stability of the oxidized starches is directly related to the stability of coatings prepared with these adhesives, and eliminates at least this one variable from the problems involved in production coating.

Acid Modification

During acid modification, the molecules of the starch are not rearranged. After cooking and cooling to coating temperature they still retain the gelation characteristics of the pearl starch, which is a serious drawback to their use.

The oxidized starches are manufactured today under very exacting conditions in the starch plant. The modifying process is mechanically controlled to reduce variables to a minimum. It produces a starch with minimum variation in color-compatibility and performance in the coating mill.

A newer starch derivative for medium solids coating is ethylene oxide

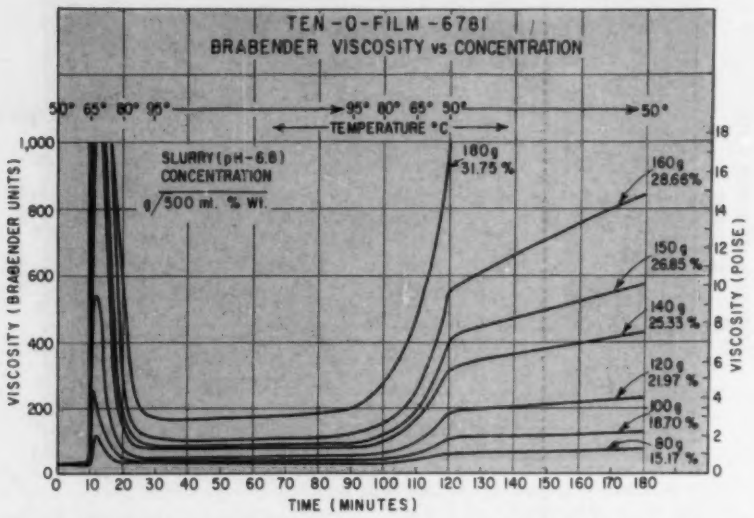


FIG. 3—Brabender amylograph shows that ethylene oxide starch is not as highly degraded as the oxidized starch shown in Figure 2.

derivatized starch which is also manufactured by the wet process.

Lowering the viscosity must be stopped at some point short of maximum reduction to avoid the production of water soluble material which would be lost in the washing operation prior to drying.

Consequently, neither the oxidized nor the ethylene oxide starch is converted sufficiently for use in high solids coating where a minimum of water is used in preparing the adhesive. They have proved highly suited, however, to medium and low solids work, because of their excellent water holding properties and low fluidity.

Improved Ink Receptivity

An interesting characteristic observed in the use of ethylene oxide starch as a coating binder is improved ink receptivity. The coated sheet possesses better printability due to the fact that less ink can be used per impression.

As a class, the ethylene oxide starches are somewhat more expensive than the oxidized type. They are especially suitable as coating binders in the production of higher grades of coated paper, where their unusual stability of viscosity and freedom from setback help produce extremely uniform coatings.

The Brabender amylograph for Ten-On-Film Grade 6781 (Figure 3) shows that this ethylene oxide starch is not as highly degraded as the oxidized starch Grade 5591 (Figure 2), but that this type of product will have good viscosity stability. Unfortunately, Brabender curves tell us only of the viscosity characteristics of a particular starch, and offer no explanation in themselves for the excellent film forming ability and film strength of the particular starch in question.

Besides the high and medium solids coatings, there is also a considerable tonnage of low solids coating which is applied at the machine size press. Size press application is the oldest and most commonly used application of coat weight. Generally speaking, the solids in press coating run rather low—20-30 per cent—although some mills raise the solids by blending with latex for higher density and coatable viscosity.

The original purpose of size press coating was to apply a low solids film of high brightness pigment blended with a starch adhesive to improve sheet brightness and also to increase the ash content of the paper.

Applying Coating Color

The principle of applying the coating color at the press is the same as in high or medium solids coating. The coating slip is metered to the rolls of the press, applied to the sheet and smoothed out to avoid an uneven or wavy coating.

Because of the low solids of the coating color, the ratio of adhesive to pigment will be high. Usually the starch and pigment are on a one-to-one basis for ample adhesion to the sheet, and a high opacity pigment must be used to cover the rawstock. Because of the low solids of the slip, care should be taken in selecting a starch adhesive which has ample water retention. The water must not be released too quickly—before the coating is smoothed—nor held too long so that uneven coating and puddles result.

Starches commonly used for size press application are oxidized and ethylene oxide starches similar to those used for medium solids coating, but of somewhat heavier viscosity.

Note: Starch grades mentioned here refer to Corn Products Sales Co. items.

About the Author . . .

CLAUDE H. FLETCHER received his scientific training at Western University. On leaving school, he joined Bryant Paper Co., Kalamazoo, Mich., engaging in laboratory and test station work for ten years. His next assignment was with Time, Inc., in its Kalamazoo research laboratory, where paper and printing methods are investigated. He remained there for two years, and in 1948 joined Corn Products. He is a member of TAPPI and other organizations.

Thiokol Sponsors Building Industry Forum

Polysulfide Sealants Subject of Meeting Held in New York City on January 28th

More than 600 architects and engineers attending the recent Building Industry Forum heard Albert Dietz, professor of architecture, Massachusetts Institute of Technology, predict that current "trends in the building industry . . . will lead to increased reliance on sealants." The Forum, first in a series to be sponsored by the Thiokol Chemical Corp., was held at the Roosevelt Hotel, New York, N. Y., to acquaint local industry representatives with the properties and possibilities of polysulfide sealants.

Serving with Professor Dietz on the Forum were Wayne F. Koppes, architect-consultant, who acted as moderator; Francis Frybergh, specifications chief, Skidmore-Owings-Merrill; W. S. Kinne, Jr., general manager of contract architectural metals, Kawneer Co.; George Grenadier, president, Grenadier Corp.; Robert McKinley, Pittsburgh Plate Glass; H. F. Johnson, Aluminum Company of America; and J. R. Panek, manager, Thiokol Chemical Corp.

Professor Dietz emphasized four factors responsible for the growing importance of sealants: increased use of shop-built components assembled in the field, the growing tendency towards shell construction, the introduction of new materials, and the increased employment of combinations of materials. He pointed out that polysulfide sealants "will go the whole way in solving the joint problem" if joints and seams are designed with the sealants' potentials and limitations in mind.

Curtain Wall Construction

Referring specifically to curtain wall construction, Wayne Koppes noted that most of the trouble that crops up can be blamed on mistakes made in sealing joints. "Materials used with conventional masonry construction won't do," he warned.

Francis Frybergh pointed out that some of the pressing problems connected with polysulfide sealants were the unavailability of adequate literature, the absence of specifications and standards, inadequate technical assistance, and the need for training schools.

Polysulfide sealants were "exceptionally usable" where production control is good, reported Mr. Kinne. "In the field, too," he said, "we have found them best when nothing else would work." This was found especially true in buildings where dimensional field tolerance were hard to control or predict from a design angle.

From his experience with polysulfide sealants in 60 major weatherproofing jobs, George Grenadier rejected the contention that polysulfides were difficult to apply. To illustrate his point he invited members of the audience to try their hand at sealing windows that were on display elsewhere in the conference hall.

Wayne F. Koppes, architect-consultant, opens the Building Industry Forum on Polysulfide Sealants held at New York's Hotel Roosevelt. Formal talks were followed by a question and answer period from the audience. Over 600 industry representatives attended.

The ease of application of polysulfide sealants was emphasized by demonstrations held after the talks.

In the question and answer period which followed the formal talks, Mr. Panek promised a one-package system for the early future. He also noted that the staining problem was being corrected. The use of spacers to position the glass in the opening was recommended by Mr. McKinley. Mr. Johnson pointed out that Alcoa uses polysulfide extensively in aluminum windows and many other areas of building surfaces. "There has been no problem of adherence to anodized surfaces or bare aluminum, but there have been indications of non-adherence on lacquered surfaces," he explained.

Literally hundreds of question cards were submitted to the panel. Those which there was no time to answer at the meeting will be answered by mail. All questions and answers will be compiled into a booklet which will be available free by writing to Thiokol Chemical Corp., 780 North Clinton Avenue, Trenton 7, N. J., on organization or school letterhead.

Executive Appointments

Pierce & Stevens Chemical Corp., Buffalo, N.Y., has announced the election of Arthur L. Stevens as president, Raymond D. Stevens as board chairman, and Raymond D. Stevens, Jr., as executive vice-president. The company has also announced the formation of three new executive posts. Francis M. Jeffe has been named vice-president, Industrial Division; Herman J. Deney, vice-president, research; and Darwin E. Ellis, vice-president, production.

A-D-M Appoints Three

Archer-Daniels-Midland Co., Minneapolis, Minn., has announced the appointment of James R. Blegen as manager of technical service for coatings. The company also has appointed Robert A. Boller as group leader in coatings and resins research and development, and Owen E. Paukner to the post of manager of the Minneapolis technical service laboratory for coatings materials and resins.

France Combines Fairs

France's Twelfth Annual Packaging Fair and Seventh International Materials Handling Fair were combined last year and held at the new Centre National des Industries et des Techniques exhibition hall, on the outskirts of Paris, on November 5 to 13. Products of domestic manufacture, imports and products manufactured in France under license were shown by 400 commercial exhibitors for the packaging industry, and 300 for the materials handling industry. Total attendance was estimated at 90,000. The next annual event of these two industries, which will also be combined with the Office Equipment Exhibition, has been scheduled for October 15 to 25, 1959.

Expands Epoxy Plant

Pennsylvania Lacquer Center, Philadelphia, Penna., has announced the expansion of its Haddonfield, N. J., plant. The 5000 square foot addition will be used for the manufacture of epoxies.

SPE Meeting Features Session on Adhesives

A special session devoted entirely to new developments in industrial adhesives was featured on the program of the 15th Annual Technical Conference of the Society of Plastics Engineers, Inc., held on January 27-30, in New York City. More than 300 industry representatives heard talks by E. M. Chmiel, Adhesives, Coatings and Sealers Division, Minnesota Mining and Mfg. Co.; Martin M. Grover, Rubber and Asbestos Corp.; John C. Eldridge, United Shoe Machinery Corp.; and H. W. Coover, Jr., F. B. Joyner, N. H. Shearer and T. H. Wicker, Jr., Tennessee Eastman Co. Jerome Been, Rubber and Asbestos Corp., served as moderator.

Mr. Chmiel, whose topic was "New Developments in 100% Solids Elastomeric Adhesives," pointed out that recent polymer technology has resulted in liquid or semi-liquid materials that readily convert to an elastomer stage. He noted that these developments have resulted in new ideas in adhesive applications.

"New Developments in 100% Solids Epoxy Adhesives" was the title of Mr. Grover's talk. He reviewed the bonding potentialities of the newer resins such as the novolac and peracetic acid derived epoxies. These, he explained, will permit the development of adhesives with higher service temperatures than are now available.

New techniques in the handling and application of hot melt adhesives were discussed by John Eldridge in his talk entitled "New Hot Melt Adhesives and Applying Equipment." The advantages and limitations of hot melts in cordlike form were reviewed with emphasis on controlled heating, versatility, metering and ease of handling.

H. W. Coover, who presented the paper of the Tennessee Eastman Co. group, spoke on "Chemistry and Performance of Cyanoacrylate Adhesives." He explained that the basis for a radically new type of adhesive lay in the fact that alkyl 2-cyanoacrylates undergo rapid, spontaneous polymerization to form strong bonds when pressed into a thin film between two surfaces. The adhesive, he noted, functions by an anionic polymerization catalyzed by traces of water or other weak bases present on the adherend surfaces.

The next SPE Annual Technical Conference will be held in Chicago, January 12-15, 1960.

SPI Division Holds Chicago Conference

Two important papers relating problems of adhesive bonding to the use of reinforced plastics were presented at the 14th Annual Exhibit and Conference sponsored by the Reinforced Plastics Division of The Society of the Plastics Industry, Inc. The conference was held in Chicago, February 3-5, 1959, and attended by more than 1,200 industry representatives.

Focusing attention on problems of adhesive technology and application were talks by Richard H. Wagner, Reinforced Plastics Laboratory, Owens-Corning Fiberglas Corp., and Professor John E. Rutzler, Jr., Department of Chemistry and Chemical Engineering, Case Institute of Technology.

Speaking on "Adhesive Bonding of Reinforced Plastics," Mr. Wagner outlined some of the practical aspects of chemical bonding. He covered the molding, machining and cleaning of the adherends and the relationship of these operations to successful bonding. In addition, he went into proper methods of adhesive mixing, applying and curing. The importance of adequate training for adhesive operators was stressed, and it was pointed out that the determining factor in the quality of an adhesive joint is often the operator's skill.

Describes Bond Types

"Type of Bonds Involved in Adhesion" was the title of Prof. Rutzler's talk. An attempt was made to show that much of the surface of an adherend is not involved in molecular interactions with an adhesive in the process of bonding. He pointed out that if this is true, stronger interactions between an adhesive and an adherend are required than the van der Waals' forces that frequently are believed to be responsible for adhesion.

An annual market study released at the conference revealed that the reinforced plastics industry showed record sales of 185,000,000 pounds in 1958, an increase of ten per cent over 1957. Significant new uses of these materials were featured at the exhibit run in conjunction with the conference.

Want to attend meetings where adhesives problems are discussed? See "Coming Events" on page 48 of this issue.

Plywood Glues Plant On Stream

The Chemical Division of Balfour, Guthrie & Co., Ltd., Seattle, Wash., has announced that its recently completed plywood glues plant in Tacoma, Wash., has an annual capacity of over ten million pounds of resin glues for the plywood and forest products industry. The new $400,000 plant adds a resin glue line to Balfour's long established protein glues, sold under their Woodweld label. With the completion of the new plant, the company established a Chemical Division to handle its glue business, and named D. E. Baldwin, manager of the firm's glue business for over 15 years, to the post of general manager of the new division.

Hooker Research Center

Hooker Chemical Corp., Niagara Falls, N. Y., has announced completion of a new Research Center, located on a 61 acre site at Grand Island, N. Y. Dedication and formal opening of the facility, the final cost of which will approximate $3,800,000, is scheduled to take place in May. The center will be under the direction of Dr. Chris A. Steigman, technical director, with Dr. J. Howard Brown as general manager for Niagara research and development. Although the facility provides space for about 200 personnel, initially 111 people will occupy the 69,000 square foot building.

Several kinds of research will be conducted at the new facility. Organic chemical research will include work on organophosphorous compounds, chlorinated products, sulfur compounds and fluorinated materials. This program will also include research on polyesters, alkyd foams and new exploratory polymer research. The inorganic chemical research group will work toward the development of inorganic phosphorous materials and an expansion of product lines including chlorine and caustic soda diversification. Considerable research effort will also be expended in exploring fields completely new to Hooker.

Durez Resin For Cements

Durez Plastics Division of the Hooker Chemical Corp., North Tonawanda, N. Y., has announced the development and availability of Durez 19428, a heat-reactive phenolic resin for use principally in neoprene cements. Neoprene cements are used in the shoe and automotive industries and as general industrial adhesives. According to Durez, the addition of a suitable phenolic resin to neoprene cement formulations results in better adhesion to Dacron, nylon, rayon, glass metals and unplasticized plastic films, and also minimizes the tendency of bonded fabrics to deteriorate in sunlight.

J-G Plans Adhesive Unit

J-G Chemists Co., St. Louis, Mo., has announced that it will open a new adhesive plant in Murray, Ky., this spring. The new, modern plant will be the headquarters for manufacturing, research and sales when operations are transferred from St. Louis to Murray. According to the company, the location of the new plant will facilitate the shipping of products to customers from coast to coast. J-G, which also has a plant in Miami, Fla., manufactures industrial adhesives for the printing, carpet and display fields.

BRI Meeting Features Technical Workshops

The Eighth Annual Meeting of the Building Research Institute, to be held at the Penn-Sheraton Hotel, Pittsburgh, Penna., on April 7 and 8, will feature half-day and full-day technical workshops on a wide variety of subjects. A workshop, to be divided into two half-day periods, will be devoted to newest developments in "Sealants for Curtain Walls," presented by the Institute's Subcommittee on Sealants under the chairmanship of architectural consultant Wayne F. Koppes. Reports will include data on all of the newer types of sealants and gaskets developed since the BRI Conference on "Adhesives and Sealants" in December 1957, and also on new testing procedures for curtain wall tightness, both static and dynamic. This workshop will feature twelve to fifteen speakers along with five to ten panel members to assist with the discussion of each topic.

Workshop on Windows

Two half-day sessions will also be devoted to a "Workshop on Windows," developed by BRI's Building Operation and Maintenance Study Group, in which design, selection, operation and maintenance of windows will be analyzed by a panel of 25 architects, engineers and manufacturers in terms of the problems encountered by building owners and maintenance men. Chairman for this section of the program will be Howard E. Phillips (American Telephone and Telegraph).

"Mechanical Fasteners in Building," under the chairmanship of W. R. Wyckoff, will consist of a half-day discussion of the newest and best mechanical fasteners for steel, concrete and wood construction, and for attaching industrial roofing and siding. Five separate talks will be given by authorities from the Industrial Fastening Institute, Phillips Drill Co., Independent Nail and Packing Co., and the Nelson Stud Welding Division of Gregory Industries, Inc. A panel and open floor discussion period will follow the individual talks scheduled.

Three speakers are slated to discuss the future of the building industry. Robert W. Dowling, New York financier and a member of the board of Equitable Life, will present a speech on "The Investor's Attitude toward City Planning and Building Design of the Future." Professor Burnham Kelly (Massachusetts Institute of Technology) will make the first public report on the MIT studies just completed for ACTION, with particular stress on the trends in home building, prefabrication and mobile home construction that seem to be evident for the 1960's. Internationally known architect Vincent G. Kling will present the designer's ideas on the buildings we'll be living, working and playing in during the next decade.

In materials research, a panel of six of the nation's top research directors will discuss "Research Plans for the '60's and their Potential Impact on the Buildings of 1970." Moderating the panel, will be Dr. G. A. Webb (Mellon Institute). Speakers will be Dr. J. E. Archer (Pittsburgh Plate Glass); Dr. J B. Austin (U. S. Steel); Dr. Paul W. Bachman (Koppers); E. C. Hartmann (Aluminum Co. of America); Dr. S. W. Herwald (Westinghouse Electric); and Dr. Lawrence C. Hicks (Allegheny Ludlum Steel).

A unit of the National Academy of Sciences-National Research Council, BRI makes this meeting open to the interested public, as it does its other conferences. Additional program information and registration material may be obtained from Harold Horowitz, technical secretary, Building Research Institute, 2101 Constitution Ave., Washington 25, D. C.

Borden Names Stainsby

H. W. Stainsby has been appointed production manager for the Borden Chemical Co. (Canada) Ltd., in which capacity he will be responsible for production of the company's full line of industrial adhesives, coatings, and building materials. Mr. Stainsby joined the Canadian affiliate of the Borden Chemical Co. in 1957.

Michigan State Forms Packaging Foundation

A non-profit organization, the Packaging Foundation, has been established to assist in the financial support of the School of Packaging at Michigan State University, East Lansing, Mich. The funds are expected to enable the University, which already has an operating program of packaging education, to expand its program to a level more appropriate to the over-all importance of the field. The program will include provision for a physical plant, appropriation for basic research, and the support of a postgraduate program at an estimated cost of approximately $2 million.

According to the Packaging Foundation, increased physical facilities and staff will enable the University to accept many practical packaging problems for solution, and an expanded graduate program will result in the expansion of basic packaging research activity at the University. Development of an expanded course program will require the collection and coordination of a great mass of packaging knowledge, which will be made available to supporting industries.

A board of fifteen trustees, twelve from industry and three from the University, will govern the foundation and Harry Walter, executive director, will administer its operations. To assist the University in the expansion of its program as funds are made available, an advisory committee of experienced packaging experts, to be selected by the foundation trustees, will be formed.

Adhesives Folders

Shawinigan Resins Corp., Springfield, Mass., has published a new series of four-page folders on adhesives applications of the company's products. The folders describe physical properties of 54 grades of resin now in commercial use in the manufacture of adhesives. Separate folders discuss the use of these products in specific adhesive applications including heat seal, hot melt, remoistenable, structural, furniture, solvent and bookbinding adhesives. There is also a section on technical service assistance in the manufacture of adhesives, which is available to users of Shawinigan materials. Copies of the folders are available on request from the company. Write to Department MC.

Glue Room Economy

Evans Products, Ltd., Vancouver, British Columbia, Canada, has announced that a minor mechanical change has resulted in considerable improvement in glue room efficiency, economy and cleanliness. In its glue room, the company has attached a small air line to the bottom of the glue mixing tank. The line, under 100 psi, provides enough agitation to keep "mud" from forming around the mixing paddle shaft, eliminating lumps in the glue mix. Only a small amount of air is let in so that the mix does not bubble up. This novel agitation method enables the glue to flow more easily, eliminates waste and makes clean-up simpler.

Adhesives For Building

A booklet entitled "Synthetic Resins in the Building Industry" issued by Aero Research, Ltd., Duxford, Cambridge, England, states that today, timber trusses assembled with synthetic adhesives compare favorably with those made with nails and connectors. The booklet describes the company's various synthetic resin glues with illustrations showing their applications.

Bonding In Aircraft

A survey on the use of Redux adhesives for bonding metal joints in modern aircraft has been made at the Fokker aircraft factory in Holland. Results of the survey, published originally in a periodical called *Luftfahrttechnik*, have been reproduced as Bulletin No. 184 in the Aero Research Technical Notes series issued by Aero Research, Ltd., Duxford, Cambridge, England, producer of Redux. According to the bulletin, Redux adhesive comprises a resin with a basis of phenol-formaldehyde and polyvinyl formal. Metal joints bonded with this adhesive are said to have a shear resistance equal to or greater than the sheer resistance of riveted joints.

Listing other advantages of the adhesive, the bulletin states that in riveted joints, the forces to be transmitted are concentrated on each rivet, but with an adhesive-bonded joint, the forces cover the whole area of the joints. Therefore, the components to be connected can be less rigid when a bonded joint is used which results in a saving in weight. The absence of rivets has the additional advantage of reducing the air resistance of the structure, the bulletin states.

Opens New Sales Office

A new Southeastern sales office has been opened by the Chemical Division of General Mills at 213 East Moorhead Street, Charlotte, N. C. The office is a part of the division's expanded sales-service program intended to better serve the raw material and technical needs of its customers. The division produces fatty nitrogen compounds, Versamid polyamide resins, Genamid liquid epoxy curing agents, Deriphat amphoteric surfactants, sterols and other chemical specialty products. It serves such industries as adhesives, plastics, coatings, soaps and detergents, mining, petroleum, pharaceuticals and textiles.

Mutual Installs Gluers

Mutual Plywood Corp., Samoa, Calif., has announced the installation of two Mann-Russell edge gluers in its plant. According to the company, controls have been added to the clippers and a sliding head has been installed on the Coe lathes. The firm has also announced that its stockholders voted favorably on the proposal by U.S. Plywood Corp. to buy Mutual for $7.5 million.

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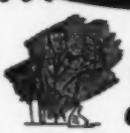

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Mar. 9-14. American Toy Fair, New Yorker and Sheraton-McAlpin Hotels, New York, N. Y.

Mar. 17-19. 15th Annual Conference and Corrosion Show, National Association of Corrosion Engineers, Sherman Hotel, Chicago, Ill.

Mar. 31-April 3. National Aeronautical Production Forum and Engineering Display, Hotel Commodore, New York, N. Y.

April 5-10. American Chemical Society, Biltmore Hotel, Boston, Mass.

April 5-10. Atomic Industrial Forum-Atom Fair, Cleveland, Ohio.

April 6-8. 8th Annual Meeting of the Building Research Institute, Penn-Sheraton Hotel, Pittsburgh, Penna.

April 13-17. National Packaging Exposition, International Amphitheatre, Chicago, Ill.

April 29-30. Manufacturing Chemists' Association, Engineering and Scientific Center, Cleveland, Ohio.

May 17-21. 61st Annual Meeting of the American Ceramic Society, Palmer House, Chicago, Ill.

May 25-27. 10th TAPPI Coating Conference, Statler Hotel, Boston, Mass.

May 25-27. 42nd Annual Conference of The Chemical Institute of Canada, Halifax, Nova Scotia.

May 25-28. Design Engineering Show, Convention Hall, Philadelphia, Penna.

May 25-28. Office Machinery & Equipment Exposition, Municipal Auditorium, New Orleans, La.

June 9-12. Material Handling Institute Exposition, Public Auditorium, Cleveland, Ohio.

June 15-19. Annual Meeting of the American Society for Engineering Education, Pittsburgh, Penna.

June 21-26. American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 22-27. Railway Supply Mfrs. Association, Convention Hall, Atlantic City, N. J.

July 1-19. Chicago International Fair Exposition, Navy Pier, Chicago, Ill.

Aug. 18-21. 10th TAPPI Testing Conference, Multnomah Hotel, Portland, Ore.

Sept. 10-11. ASME Wood Industries Conference, Multnomah Hotel, Portland, Ore.

Niax Triol LK-380

Union Carbide Chemicals Co., New York, N.Y., has announced the availability of a new polypropylene glycol polyether called Niax Triol LK-380. According to the company, the new product is aimed at rigid urethane foams but can be evaluated for use in urethane coatings and adhesives. Niax Triol LK-380 offers better aging characteristics, lower water sensitivity and better economics than the polyesters used to make rigid urethane foams, Union Carbide states. Rigid foams in which the new polyether can be applied would be such products as insulation for refrigerators and freezers, refrigerated transportation equipment, and sandwich board.

New Marblette Offices

Two new sales offices in Illinois have been announced by Marblette Corp., Long Island City, N. Y., supplier of epoxy and phenolic resins for adhesive bonding, protective coating, plastic tooling and other purposes. In Chicago, a new office staffed by Robert Ross and James Brock was opened at 5655 W. North Ave. Operating in conjunction with this office is R. S. & W. Industries, located in Pekin, Ill., and headed by R. C. Seegar. The territory covered by the Illinois representative includes North and South Dakota, Minnesota, Iowa, Wisconsin, Indiana and Illinois.

ASME Meeting Program

The Fourth Design Engineering Conference, to be held at Convention Hall, Philadelphia, Penna., on May 25 to 28, will consider the means of making more effective use of the talents of engineers by the companies which employ them. Sponsored by the Machine Design Division of the American Society of Mechanical Engineers, the conference will be held concurrently with the Design Engineering Show.

The show, which will feature exhibits to help companies in the design of new end products, will demonstrate mechanical components, power transmission equipment, electrical and electronic components, metals, non-metallic materials, fasteners and adhesives, finishes and coatings, shapes and forms, hydraulic and pneumatic components, and various engineering equipment and services.

At the technical sessions, which will be held during the mornings, there will be two conference sessions dealing with more efficient use of engineering talents and skills. The first will consider the philosophy of engineering design in foreign countries. This will be a panel session on design created by designers who are free to work in accordance with their beliefs, as contrasted with designers who are influenced by sales, marketing or consumer motivation. The second session will discuss the efficient organization of a design department to the advantage of company operations and for proper use of the engineer's talents.

There will also be three concurrent sessions dealing with choice of materials in design, mechanical aspects of design and power and control. Discussions at the materials session will include "Latest Developments in Plastics, Metal and Ceramics for 1000°F. Service," and "Latest Developments in Materials and Coatings to Resist Corrosion." The mechanical session will be devoted to methods of power transmission and the theory and selection of bearings. The power and control sessions will consist of discussions on "Direct Current Drive Systems and Conversion Devices" and "Digital Systems and Logic Circuits for Controls."

Pucel Enterprises, Inc., Cleveland, Ohio, is marketing all welded "Grizzly" drum cradles that are designed for rugged use and are available with or without cradles. Grizzly drum storage racks are also available in four or six drum capacities.

TAPPI Adhesive Group Plans Monograph

At a recent meeting of the Adhesive Testing Committee of the Technical Association of the Pulp and Paper Industry, New York, N. Y., the group decided to concentrate its activities on the preparation of a monograph, to be designated as Project No. 713. Projects previously planned, including No. 613 on Bonding, No. 614 on Tack, No. 627 on Machinability and No. 628 on Humidity and Temperature, have been cancelled in order that the group might devote its full attention to the monograph.

Chapters to be included in this work will be "Plasticizers for Adhesives," by Karl M. Fox (Scott Paper); "Resin Emulsion Adhesives," by Morris Breslouf, et al (Borden); "Remoistenable Adhesives," by J. P. Carey (Dennison Manufacturing) and J. J. Minelli (Eureka Specialty); "Pressure Sensitive Adhesives," by R. W. Howard (Fasson Products); "Foil Adhesives," by R. D. Faunce (Reynolds Metals); "Silicate Adhesives," by R. H. Sams (Philadelphia Quartz); "Dextrins," by W. W. Sederlund (National Starch); "Soya Protein Adhesives," by Ralph Wicker (Glidden); "Tack Testing," by William Neuss (Stein, Hall); "Gummed Industries Association," by H. L. Heise (Gummed Products); and "National Association of Glue Manufacturers," by O. V. Simonson (Milligan & Higgins). In addition, chapters will be requested from Paul Yoder (Pyroxylin Products) on "Hot Melts"; from Cornwell and L. B. Lane (Armour) on "Glue"; and from Crowell (Union Paste) on "Solvent Adhesives". More data on foil laminating will also be requested from Reigel, Cochran or Polymer.

Reports on Tack Tests

During the meeting R. W. Green (Thwing Albert), a guest speaker, reported that tests on the tack tester had been completed and would be circulated soon. The rotation method was changed to a spring load from hand turning to improve reproducibility. Mr. Faunce reported on several routine test methods on adhesion which will be ready soon for issue on TAPPI standards.

Another interesting feature of the meeting was a talk presented by Dr. John Rutzler (Case Institute) on types of adhesive bond. Dr. Rutzler reviewed in detail work done with molecular models and discussed mechanical adhesion vs. specific adhesion, using data published in the Case Institute Symposium on Adhesives, which was held in 1952.

Dr. Rutzler concluded that smooth surfaces and highly polar adhesives gave bonding, but that roughening as such did not produce adhesion except as it increased surface area. Therefore, he stated, all adhesion is specific, not mechanical. He went on to discuss work on rubber-to-nylon adhesion, which confirmed that adhesive absorbed into the yarn cross section is of no help. Also, fibrils on the surface of spun yarn are helpful, while some improvement in adhesion can be gained by reaction of cellulose yarns with amine fatty acid finishes.

Polyethylene Adhesion

Dr. Rutzler then reviewed current experiments with adhesion of polyethylene and Epon 828 to metals including titanium, steel, aluminum, copper and alloys. As surface smoothness of metal increased to 25 micro inches (on Brush surface indicator) bond strength increased from 600 psi to 3800 psi to 13,000 psi maximum, the speaker stated. While these bond strengths are more than enough for practical uses such as foil laminating, they are only 1 to 2 per cent of the theoretical potential bonds. Calculated value assumes that all metal surfaces are oxidized to provide oxygen ions which then attract hydrogen ions in plastics to produce either a dipole force or a dipole to induce dipole force.

These have been measured at 0.4 to 0.5 Debye units (10^{-18} electrostatic units), or if ion dipole, about 12,000 psi. Dr. Rutzler assumes Vander Waal forces to have no effect beyond 10 Angstroms distance. Allowing for ionization of the metal, the large size of the polyethylene polymer chain, its spiral character, and the roughness of even the best finished metal, the speaker found that only 1 to 2 per cent of the potential sites of attraction can actually be considered to contribute to bonding.

Discussion Follows Talk

During the discussion which followed his talk, Dr. Rutzler stated that his theory should be adaptable to flexible metal films such as aluminum foil as well as to papers and boards, allowing for their more porous nature. Also mentioned was the use of phosphoric acid added to dextrine adhesives to improve bonds to paper.

Morningstar Expands Latex-Plastisol Units

Production of liquid vinyl chloride and natural and synthetic latex compounds has begun at the new Clifton, N. J., plant of Morningstar-Paisley in line with an expansion of the company's Latex and Plastisol Sales and Technical Departments. The new, modern plant, which includes 100,000 square feet of manufacturing space, adjoins the company's recently acquired Haberland facility. The plant will produce the bulk of plastisol, organosol and latex products in the Morningstar line.

The new plant is expected to improve service facilities, and to allow overnight service to customers. In addition, production of large batch sizes and better control of inventories, especially of raw materials, are expected to provide greater product uniformity. The production of polyvinyl acetate resin emulsions, also used in the company's adhesive product line, is expected to begin during the spring of 1959.

The plastisol line, including organosols, have been trademarked Morpasol. The latex products produced at the new Clifton plant are sold under the trade name designations Morpalex and Morpatex. Special interest has been exhibited in a Morpatex formula used in bonding scrap foam rubbers and synthetic foam fragments into useful, economical molded states for cushioning and packaging purposes. The new plant is set up to provide scientific formulations of special grades to suit customer needs.

New Eastman Office

Plastics Division of Eastman Chemical Products, Inc., Kingsport, Tenn., has established a new sales territory with headquarters at 435 Jefferson Standard Building, Greensboro, N. C. Manager of the new office is John M. Marvin, who has been with the Eastman organization for 11 years. Previously, he was sales representative at the company's Leominster, Mass., office. A graduate of Clemson College, with a B.S.M.E. degree, Mr. Marvin was a first lieutenant in the United States Army from 1943 to 1946.

The new territory has been created in order to satisfy increased customer demand and to give improved service in the area. It will include Virginia, North Carolina, and parts of South Carolina, Tennessee and Kentucky.

names in the news

Walter F. H. Mattlage has been appointed general manager for the Fabrics and Finishes Department of E. I. du Pont de Nemours & Co., Inc., succeeding **E. S. Nickerson**, who has retired after a career of 43 years.

William H. Martin, formerly with Batten, Barton, Durstine & Osborn, Inc., takes up the job of marketing research manager of the Borden Co.'s Corporate Marketing Coordination Department.

William H. Parkinson assumes the responsibilities of advertising director of the Paterson Parchment Paper Co. He was previously with the H. K. Porter Co.

John Delmonte, president of Furane Plastics and member of the ADHESIVES AGE Editorial Advisory Board, was one of the featured speakers at a recent panel discussion on reinforced plastics sponsored by the Pacific Coast Section of the SPI.

William B. Nicholson moves up to vice-president of Linde Co., a division of Union Carbide Corp. With Union Carbide since 1935, he originally joined the company as an engineer in the development laboratory of Linde Co.

Arthur C. Dreshfield was named director of paper research and development for The Glidden Co's Chemicals-Pigments-Metals Division. He will be headquartered at the division's new papermaking and coating research laboratory in Baltimore.

Francis X. O'Keefe has been appointed to the administrative sales staff of National Polychemicals, Inc. He was formerly associated with Wasco Chemical Co. as assistant to the sales manager.

Dr. Jesse Werner was elected a vice-president of General Aniline & Film Corp.

William H. Kieffer and **Dr. Charles J. Weidmann** were elected vice-presidents of CIBA Co., Inc., manufacturer of chemicals for adhesives and plastics.

Harry N. Lowell has joined the Organic Chemicals Sales Department of The Dewey & Almy Chemical Division of W. R. Grace & Co.

Richard E. Martin and **John E. McCarthy** have been appointed to the West Coast sales staff of The Shawinigan Resins Corp.

Canadian Resins Sold

With the acquisition of a 51 per cent interest held by Union Carbide Canada Ltd., Shawinigan Chemicals Ltd. will become the sole owner of Canadian Resins and Chemicals Ltd. A subsidiary of The Shawinigan Water and Power Co., Shawinigan Chemicals already has the other 49 per cent interest in Canadian Resins. Officials of Union Carbide Canada Ltd. said the company will continue to produce plastics through Bakelite Co. and Carbide Chemicals Co., both UCC divisions.

Subject to the approval of the Provincial Electricity Board, Montreal, Shawinigan Water and Power will issue not more than 125,000 additional common shares to UCC to effect the purchase. The company announcement pointed out that the acquisition will make it possible to integrate the operations of Canadian Resins with those of Shawinigan's nearby plants.

Brown Named Director

Richard C. Brown has been appointed director of the laboratory for the United States Envelope Co., Metuchen, N. J. Previously serving as assistant director of the laboratory, Mr. Brown succeeds Dr. Roy C. Charron, who retired December 31. Dr. Charron will continue to serve the company in an advisory and consulting capacity to the laboratory and will maintain an office in the laboratory building.

Portrait Of

John R. Hubbard

Vice-president in charge of production for Peter Cooper Corp., Mr. Hubbard recently became a member of the Editorial Advisory Board of ADHESIVES AGE. For the past 30 years he has been actively connected with various aspects of the adhesive industry. In 1929, he received his B.S. in chemistry from Tufts College and entered the laboratory of Crystal Gelatin Co., Peabody, Mass., then a part of the American Glue Co. He was soon assigned to the company's production units.

On the merger of the American Glue Co. with Peter Cooper Glue Co. to form Peter Cooper Corporations, Mr. Hubbard relocated to Gowanda, N.Y. His experience with the company, probably the world's largest hide glue producer and among the larger domestic producers of edible and technical gelatines, has included executive assignments in the laboratory, technical sales service and research development departments. In addition to his present post as production vice-president, Mr. Hubbard is also serving as Peter Cooper's technical director.

An active participant in several of the industry's more important organizations, he is an official representative to both The American Pulp and Paper Mill Superintendents Association and the American Society for Testing Materials. He is also a member of the American Chemical Society and the American Society for Testing Materials.

General Mills Seminars

General Mills, Inc. recently conducted a series of one-day seminars on the company's fatty nitrogen chemicals, which took place in heavily industrialized areas across the country. Members of the firm's Chemical Division, Kankakee, Ill., and Central Research Laboratories, Minneapolis, Minn., visited Philadelphia, New York, Chicago and Los Angeles. At these locations, they met with research directors and technical personnel from the petroleum, textile, rubber, agricultural, mining and chemical industries. General Mills personnel included in the traveling seminar panel included Dr. Harold Wittcoff, director of chemicals research; Dr. K. E. McCaleb and D. L. Andersen, Nitrogen Products Research Section; D. E. Terry, technical service manager; A. J. Freeman and J. E. House, Development Department.

The discussions covered the chemistry, applications and potential applications of the company's long chain fatty amines, diamines and quaternary ammonium chlorides. These chemicals are now in use in industry as petroleum product additives, ore flotation reagents, mold release agents for hard rubber products, textile conditioners, corrosion inhibitors and bactericides, and chemical intermediates. A new line of chemical products were also introduced as commercially available items.

Solvent Recovery Unit

Vic Manufacturing Co., Minneapolis, Minn., has announced the availability of a small, packaged solvent recovery unit for industrial plants using small quantities of solvents. Various problems found in recovering solvent vapors at these plants necessitated the development of many novel features in the Vic solvent recovery packaged unit. These new features are said to produce highly efficient results and to enable the company to sell solvent vapor recovery systems at reasonable prices. In addition to its novel features, each unit also contains Columbia activated carbon, furnished by Union Carbide, with a specific charge of carbon provided for each application. Union Carbide's carbon provides maximum recovery of solvent vapors and years of service life.

Maraset Epoxy Resins

Marblette Corp., Long Island City, N. Y., has introduced a new Maraset epoxy resin system for casting, laminating and adhesive uses where high heat resistance is required. According to the company, the new multi-functional liquid resin comes in two formulations. Resin 617-A is aluminum filled, while Resin 617-C is clear. Both have low viscosity, which can be maintained at room temperature after they are opened for as long as 30 minutes.

The company reports that even after mixture with a Marblette hardener provided for polymerizing both types of this resin, the viscosity can be repeatedly lowered to a point suitable for laminating by heating the resin-hardener blend to above 65°C. In both filled and clear forms, Resin 617 is said to exhibit heat resistance up to operating temperatures as high as 500°F. Its heat distortion point is 425°F. At higher temperatures, it retains elasticity and does not exhibit the tendency to break, which is characteristic of epoxy compounds whose maximum deformation is twice that of Resin 617, the company states.

Adhesives for Wood

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patent review

By MELVIN NORD

Starch Products

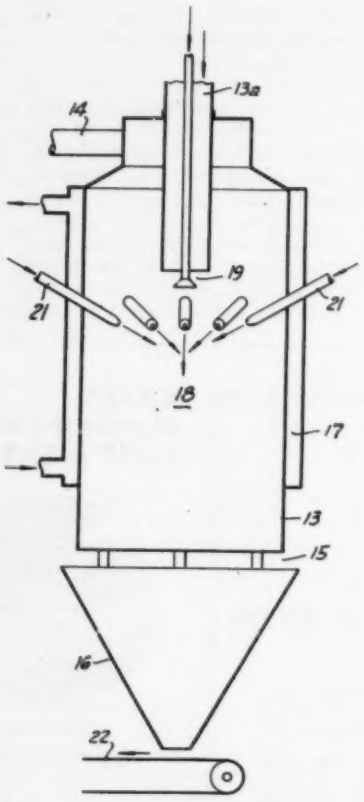
U. S. Patent 2,856,290, issued October 14, 1958 to David D. Peebles and assigned to Foremost Dairies, Inc., describes a method of manufacturing dry starch products which are free-flowing.

Commercial powdered starch is dry mixed with a dry powdered material containing substantial amounts of lactose and milk protein, such as dry skim milk powder of the type produced by commercial spray drying. In practice the amount of skim milk powder introduced may consist of from 15 to 25% by weight of the total mix. The dry mix is subjected to a special moistening and aggregating operation, during the course of which a considerable amount of moisture is absorbed. The moist aggregated material is then subjected to drying to produce a final product having a moisture content comparable to the original commercial starch. The drying is carried out in such a manner that the aggregated form of the material is left substantially intact.

The schematic illustrates suitable equipment for carrying out the moistening and aggregating operation. It consists of a vertical chamber (13) having a downwardly extending inlet conduit (13a) for receiving the powdered starch conveyed pneumatically from a supply hopper. Some air is removed from the chamber through a conduit (14), air being drawn into the chamber through the lower opening (15) between the main part of the chamber and the discharge hopper (16). The sides of the chamber can be kept warm by circulating warm air through the jacket (17), thereby preventing the condensing of moisture on the inner chamber surfaces.

The free falling powder passes through a zone (18) where it is mixed with finely atomized water discharged from a nozzle (19). Also, some saturated steam is introduced by way of other nozzles (21). The falling powder acquires moisture, so that the material discharged on the lower conveyor (22) has a moisture content ranging from about 20 to 25%. The preferred temperature level within the zone (18) can be of the order of 80 to 140°F., 120°F. being optimum.

As the particles of powder are commingled with the vapor and atomized water, moisture distributes



itself on the surfaces of the particles. Considerable moisture is absorbed by both the starch and the particles of skim milk powder, and the latter acquire a surface stickiness. Sufficient commingling takes place within the treatment zone whereby particles are brought into direct contact, with the result that particles adhere together in the form of random aggregates.

The time period of treatment in the equipment may range from 10 to 60 seconds. The aggregates discharged from the lower end of the equipment are relatively soft and porous, and will not withstand mechanical handling. They are permitted to rest without handling, as for example on the moving belt (22), and are conveyed to the finish dryer. The period of rest may range, for example, from 30 to 90 seconds. During transit there is a lowering of the temperature level with the result that the aggregates become firmer and less sticky.

Adhesive Compositions

U. S. Patent 2,857,356, issued October 21, 1958 to John T. Goodwin and assigned to General Electric Co., discloses certain organopoly-siloxane compositions having pressure-sensitive adhesive properties over a wide temperature range, and which have a low level of moisture sensitivity.

The adhesives are obtained by intercondensing (1) a cohydrolysis resin product of a trialkyl hydrolyzable silane and alkyl silicate, and (2) a linear, high viscosity organo polysiloxane fluid containing terminal silicon-bonded hydroxy groups. The two are mixed together and heated to 100 to 150°C., which removes solvent present in the resin solution.

Dry Rosin Size

U. S. Patent 2,855,391, issued October 7, 1958 to Charles R. Rothenanger, Sr. assigned to American Cyanamid Co., describes a method for the manufacture of dry rosin size, in which a molten rosin is saponified with aqueous alkali metal carbonate solution, and the liquid rosin size thus formed is dried on a hot surface to thin powdery flakes.

The invention is particularly directed at increasing the efficiency of the drying step by degassing the liquid rosin size prior to drying.

Dextrin Starch Paste

U. S. Patent 2,856,307, issued October 14, 1958 to Ralph E. C. Fredrickson and assigned to A. E. Staley Mfg. Co., relates to the use of raw or unmodified native starch to reduce or prevent "set-back" of dextrin pastes, i. e., increasing in viscosity on standing.

It has been found that the incorporation of 5% or more of raw starch to a dextrin paste results in a set-back resistance which is very much better than that of dextrin or of starch paste.

Alkyl Ethers of Starch

U. S. Patent 2,858,305, issued October 28, 1958 to Ralph W. Kerr and assigned to Corn Products Refining Co., describes a process for the preparation of alkyl ethers of starch in unswollen granule form.

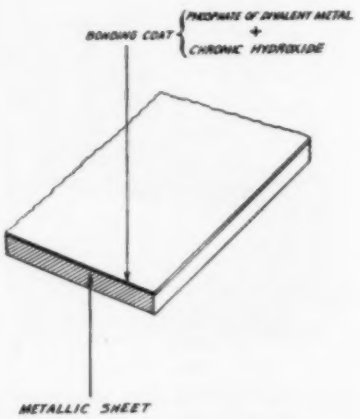
Starch in the unswollen granule state is stirred into a 10 to 25% Na_2SO_4 salt solution, into which about 0.5 mole of NaOH per mole of starch has been dissolved. Although the pH of this slurry may be about 11, the starch does not gelatinize. Then, with vigorous stirring, and while heating to 40 to 50°C., sufficient dimethyl sulfate is added to depress the pH level to 10.5. Then, additional dimethyl sulfate and caustic are added simultaneously, maintaining the pH at 10 to 11.

The reaction proceeds for several hours, until a substantial proportion of the reagent has reacted with the starch. The alkyl starch, still in the unswollen granule state, is then resuspended, neutralized by adding an acid, filtered, washed with water, and dried.

Bonding Metal Surfaces

U.S. Patent 2,846,342, issued August 5, 1958 to Leo P. Curtin, relates to the production of adherent bonding coats on aluminum, zinc or ferrous metal surfaces.

The process consists of the following steps: (1) freeing the metal surface from water-breaks, (2) wetting the metal surface with a solution containing chromic acid or ammonium dichromate, and also containing a hypophosphite reducing agent for the chromate (free hypophosphorous acid or calcium, magnesium or zinc hypophosphite), and (3) destroying completely any oxidants and reducing substances present in the film of chromate solution adhering to the metal surface by heating to a temperature above 100°C. The residue remaining on the metal surface constituting an adherent, chromic hydroxide-phosphate bonding coat. The resulting product is shown in the schematic diagram.

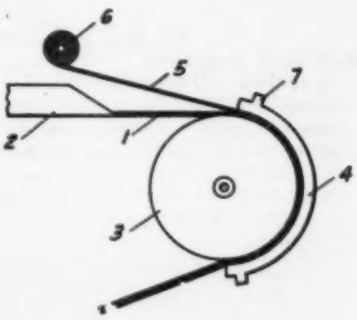


Silicone Rubber Tape

U. S. Patent 2,854,698, issued October 7, 1958 to Delmar C. Youngs, and assigned to Dow Corning Corp., describes a method of making "unsupported" pressure-sensitive silicone rubber tape—that is, tape which contains no reinforcing sheets, fabrics, or fibers.

As shown in the schematic drawing, a sheet of raw silicone rubber (1) is extruded from a suitable extrusion head (2) while simultaneously a slip sheet of interleaving material (such as polyethylene) (5) is pulled from a roll (6). The two sheets (1 and 5) come together at the surface of a heated revolving drum (3) and pass around this drum with one face of the silicone rubber sheet in contact with the drum while the slip sheet is in contact with a cooled shoe (4).

The shoe is provided with inlet and outlet tubes (7) through which a cooling fluid can be circulated. The



partially vulcanized silicone rubber with the interleaving material is then rolled onto a suitable roll. It can then be cut into the desired width for tape. During the passage of the silicone rubber sheet around the drum, the temperature of the heated drum and that of the cooling shoe can be so adjusted that the proper degree of vulcanization will be obtained.

Other Patents of Interest

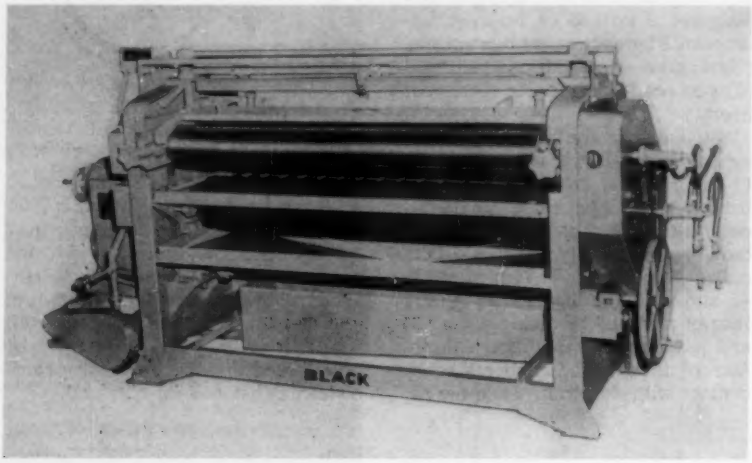
Subject	Inventor or Assignee	Patent No.	Date
Tape dispensing apparatus	Nashua Corp.	2,851,004	9/9/58
Reinforced tear-resistant material	Griffolyn Co., Inc.	2,851,389	9/9/58
Cement composition	Phillips Petroleum Co.	2,852,402	9/16/58
Fire-resistant cementitious composition	United States Gypsum Co.	2,853,394	9/23/58
Heatsealing adhesive sheets	Johnson & Johnson	2,853,404	9/23/58
High temperature resisting bonding of metallic surfaces	Secretary of the Army	2,853,412	9/23/58
Ceramic binder	American Cyanamid Co.	2,853,461	9/23/58
Tape applying machine	Louis Triolo	2,854,164	9/30/58
High temperature insulating adhesive tape	Karl Huber	2,854,352	9/30/58

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Do not send stamps.

new equipment

Roll Glue Spreader

• A resilient roll glue spreader, designated No. 22-D, is for use with resinous, casein, polyvinyls, protein and other adhesives having similar viscosities and characteristics. The machine comes in a total of 39 sizes in four different models, 8-inch through 122-inch capacities with 6-inch increments. A variable speed drive, which is optional, provides a complete range of speeds, the usual one being 50 to 150 FPM. Other features include water-cooled doctor rolls and a vertical thickness adjustment dial indicator which indicates opening between the gluing rolls in thousandths of an inch. The latter is desirable when repetitive adjustments are made for varying thickness of stock and for returning to a previous setting. Standard features include a single speed motor drive, a patented safety control, glue reservoir and plates, precision ground gluing and doctor rolls, micrometric adjustment throughout, absolute roll parallelism, heavy duty ball bearings and overrunning doctor roll clutches. *Black Brothers Co., Inc.* E-53



Electric Strip Heaters

A line of electric strip heaters, designated Chromalox, is designed to provide the exact temperature desired in a variety of commercial and laboratory operations. These include keeping heavy and viscous compounds moving smoothly; application to different kinds of ovens; keeping motors dry; and providing zoned heat for kettles. The heaters come in various shapes and sizes for different installations, and in different wattages. A thermostat can be used to insure precise control. *Edwin L. Wiegand Co.* E-54

Conveyor Belts

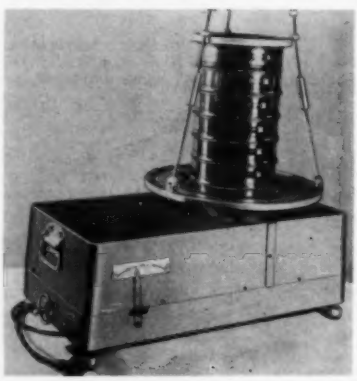
Pre-engineered conveyor belt components are designed to be easily assembled to make custom belt conveyors for specific job requirements. Assembly of the components, designated E-Z Bild, is said to require no special training. Level, inclining or declining roller bed belt conveyors of any desired length and in belt widths of 10, 14, 18 or 22 inches are said to be easily erected by unskilled personnel. The components include straight "intermediate" sections, top curves, feeder sections, drives, take-ups, belts, idlers, floor supports and ceiling hangers. Side frames are designed so that bed rollers can be set either high or low. In the latter position, the belt conveyor's side frames protect the load by serving as guard rails. *Alvey-Ferguson Co.* E-55

Humidity Indicator

The Abbeon humidity indicator provides a means of telling the exact relative humidity in the air without any calculations. The information is read directly from the dial of the unit, which is 6 inches in diameter. The instrument may be used with temperatures up to 230° F. It comes in a gleaming brass finish. A calibration adjuster is easily accessible on the lower left side of the casing, which is drilled for wall mounting. *Abbeon Supply Co.* E-56

Laboratory Sieve-Shaker

A laboratory sieve-shaker, said to be quieter-running than any other laboratory shaker, is claimed to handle all the regular ASTM and other standard sieving tests. The vibration of the Fisher/Wheeler shaker gives each particle in the sieve a combined vertical and horizontal motion that keeps the sample uniformly spread over the mesh. The rate of vibration can be varied from 500 to 900 per minute. Design of the instrument keeps the vibration from being transmitted through the base of the shaker to the lab bench and other equipment. The shaker is supplied with a holddown ring to fit over a stack of 8-inch sieves. The sieve-table is recessed to hold other sizes from 6 to 16 inches in diameter. The instrument measures 34 by 13½ inches and is 11 inches high without sieves. *Fisher Scientific Co.* E-57



Melting Point Unit

A new melting point apparatus is said to be eminently successful in carrying out accurate, reproducible determinations in minimum time. Heating is rapid to within 5 to 10 degrees of the melting point; further temperature increases can then be

reduced to 1 to 2 degrees per minute. Determination of melting points is used for the characterization of new substances, identification of compounds and purity control of products. The new unit is said to save considerable time between tests because the small mass of heating fluid used plus its low specific gravity allows rapid cooling. Without compressed air, cooling takes 10 minutes from 300 to 100°C., and eight minutes more to 60°C. With compressed air, the corresponding times are four and 1½ minutes. *Arthur S. LaPine and Co.* E-58

Convection Ovens

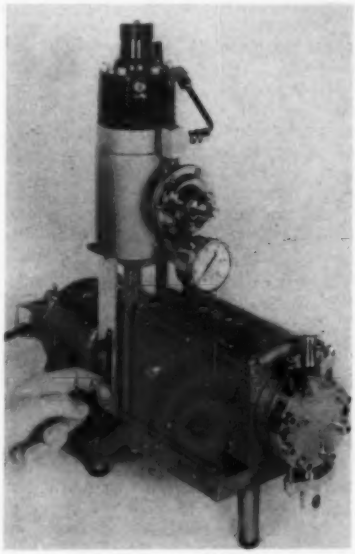
The Test-All series of mechanical convection ovens features units said to be ideal for preheating, aging, sterilizing, dehydrating, drying, baking and for analytical and general laboratory work. A motor-driven turbo blower propels heated air through a definite air flow pattern, thus insuring superior, constant uniform temperatures. The ranges of the ovens is from 40°C. to 180°C., with a response sensitivity of ±½° C. The ovens have stainless steel interiors, including the inside face of the door, and a minimum of 3-inch thick Fiberglas insulation. All wiring is complete and enclosed. Ten bench models are available in sizes from 1.5 to 24 cubic feet, as are ten equivalent standard floor models. *Blue M Electric Co.* E-59

Drum Handling Unit

A Liftomatic drum handling attachment for use with electric fork trucks is a mechanical unit designed to engage, transport, place and tier any conventional-type drum without the use of pallets or dunnage. Because the clamping mechanism is adjustable from 35 to 14 inches, any size drum regardless of height, diameter or rim size can be handled. The jaws are said to operate perfectly on steel, removable lid, fiber or light gauge (disposable) metal drum either opened or closed. The unit is said to be quickly detachable from the truck, and one man can re-attach it in 2 to 3 minutes without the use of tools. *Lewis-Shepard Products, Inc.* E-60

Automatic Metering Pump

An automatic metering pump, called Auto-Pneumatic Micro-flo Pulsafeeder, that adjusts pumping rate from zero to full capacity by signals from pneumatic instruments



is available in a variety of models with theoretical capacity ranges from 1040 to 2300 ml./hr. at zero psig. Pressures up to 2000 psig can be accommodated. The pump is designed to give the process industries a means of automatically metering chemicals without using constant level controls, measuring tanks or other devices. It is designed for heavy duty continuous service. *Process Equipment Division, Lapp Insulator Co., Inc.* E-61

Moisture Balance

An improved moisture balance for determination of the moisture content in a wide variety of materials features a built-in autotransformer which regulates voltage automatically and provides more convenient tem-

perature control than previous balances in which the autotransformer was a separate unit. The balance is said to be capable of reducing to only a few minutes the time required for accurately testing the moisture content of a substance. The instrument performs both the drying and weighing operations simultaneously, thus eliminating the time-consuming weighing of samples on an analytical balance, with subsequent drying in a vacuum oven and then reweighing. The per cent moisture loss during a determination is read directly on a calibrated scale. *Central Scientific Co.* E-62

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card elsewhere in this issue.

book reviews

Structural Adhesives. ***By Walter H. Bergler, Jr., et al. Published by Structural Adhesives Associates, 907 North 17th St., Allentown, Penna. 8½ x 11 in. 62 pp. $9.50.***

This paperbound book is the work submitted by a group of students in partial fulfillment of the requirements of a course at the Harvard Graduate School of Business Administration. Although its sub-title, "An Introduction for Potential Users," might indicate its content to be superficial, actually it treats the subject of structural adhesives with considerable depth Indeed, almost anyone except the specialist will benefit from a careful perusal.

The book is divided into three parts. The first, on fundamental concepts, has two chapters: "Theory of Adhesion," and "The Practical Aspects of Adhesives and Bonding." The former chapter describes the various conflicting concepts of the theory of adhesion, and discusses factors influencing bond strength. Basic rules in adhesive bonding are summarized.

The second chapter gives an extended discussion on classifications of adhesives, with chemical formulas for the materials used, and continues with an exposition of the various factors involved in the adhering mechanism.

The second part, on applications in industry, has chapters pertaining to aircraft, automobiles, and metalworking and construction. The third section, on the adhesives industry, has one chapter entitled "Structural Adhesive Producers." It deals with such topics as how adhesives are sold, independent sources of information and assistance, and procedures for finding the proper adhesive.

The book closes with a short "Challenge" to the adhesives industry, and three appendices: a list of manufacturers of structural adhesives and their specialties, a list of manufacturers of mixers, applicators and sprayers, and a specification check list. The book also contains a bibliography of recommended reading.

As indicated by the outline of contents, this volume contains a great deal of information. Much of it is of direct practical value, and will answer many of the questions that the man who has an adhesive problem is likely to ask. The pages on theory will suffice the non-specialist who wants a layman's knowledge of how adhesive bonds two surfaces. All in all, a well rounded and useful presentation.

Engineering Materials Handbook. ***Edited by Charles L. Mantell. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 6 x 9¼ in. Approximately 2000 pp. $21.50.***

Over 150 specialists in various fields have become authors to produce this volume. Its purpose is to supply the practicing engineer, designer, student or purchasing agent with an authoratative reference work on engineering materials. The book opens with a list of abbreviations, followed by two chapters on properties of materials and processing techniques. It then continues with 39 additional chapters on various materials, and closes with two chapters on materials problems of specific industries and sources of information. An extensive subject index follows the text.

The chapter on adhesives is divided into three parts, the first titled "Gaskets, Packings and Seals"; the second, by Roger K. Humke of the Commercial Development Department of Minnesota Mining and Manufacturing Co., "Joining Materials—Adhesives," and the third, by C. R. Payne, Electro Chemical Engineering & Manufacturing Co., "Cements."

The part on adhesives fills eleven pages. In these the author defines and discusses adhesives, their classification advantages and limitations, raw materials and end uses. Included are tables on classification of adhesives by method of setting to form the bond, classification by chemical type of basic ingredient, characteristics of rubber adhesives, and end uses of elastomeric adhesives. A long table which fills several pages is devoted to classification of adhesives by type (cellulosic, acrylic, etc.), their solvents, resistance ratings, and effectiveness of bond with various materials. Another long chart presents data on bonding of different materials, with an indication of the class of materials to be bonded and other relevant information. A list of eight literature references closes the section.

The shorter section on cements deals with the six general types used in chemical construction to resist the attack of acids, alkalies, corrosive salt solutions and other corrosive chemicals. These six types—furan, phenol-formaldehyde, epoxy, polyester, sodium silicate, and sulfur—are discussed individually, and tables present data on chemical resistance, chemical properties, and manufacturing information. The latter indicates the kind of equipment involved.

In addition to information presented in the chapter on bonding materials, numerous other references are made to adhesives, as, for example, in the chapter on rubber and in the one on plastics in regard to silicones. These references are listed in the subject index.

The book in short makes an encyclopedic presentation of basic information on a large number of engineering materials. The quality of the papers is unusually high, and the section on adhesives is no exception. The type is legible and the layout clear and logical. Most who deal with these engineering materials, either in a direct or indirect way, will have occasion to pick up this reference work not once but many times.

Trade Literature

Chemical Process Equipment. Specifications and descriptions of a complete line of blenders, vacuum tumble dryers, packaged resin-distillation pilot plants, and process heat exchangers are given in a 16-page bulletin. Using easy-to-read tables and simplified diagrams, the publication lists standard dimensions and capacities for the patented Twin Shell intensifier blender; Liquid-Solids blender; and yoke, cone and ribbon-type blenders. In addition, information is given on vacuum tumble dryers in complete packaged units from one to 150 cubic foot working capacities; packaged resin-distillation pilot plants designed for research or small batch operation; and shell and tube type heat exchangers. *Paterson Kelley Co., Inc.* L-58

Nitrocellulose Adhesives. A four-page brochure deals with the history of a company which originally sold nitrocellulose products rescued from scrap motion picture film. At present it supplies virgin nitrocellulose solutions to industry. Included are materials for nitrocellulose mastics and fast drying cements, as well as solutions for vinyl acetate and polyvinyl chloride adhesives. Two sample recipes for adhesives are given in the brochure. The company offers its services in solving formulation problems. *Cellofilm Industries, Inc.* L-59

Automatic Transfer Switches. The purpose of a 23-page publication is to present information which will help a potential user select an automatic transfer switch suited to his needs. Graphs and charts underline the importance of considerations such as instantaneous arc interruption, adequate thermal capacity, and built-in time delay. The last half of the book provides illustrated case histories of in-use operation of automatic transfer switches in various installations. *Automatic Switch Co.* L-60

Trade Literature (Cont'd.)

Rotary Batch Mixers. A four-page illustrated folder describes a line of rotary batch mixers. Special and optional features of the machines are listed, and the operation principle of the rotary mixer is illustrated with schematic diagrams. Two types of the mixers, a forced feed with gravity discharge and a gravity feed and discharge, are described and illustrated with photographs and drawings. Specification charts list the mixing capacity, weight per cubic foot, maximum load and required horsepower of the different units of each type. The back page of the bulletin has illustrations and brief descriptions of additional mixing and reducing equipment, such as attrition mills. *Munson Mill Machinery Co.* L-61

Organic Industrial Solvents. A 72-page handbook provides fundamental safety information on organic solvents and principal methods of safety control. It covers in detail the physical, chemical and toxicological properties of the common industrial solvents upon which the nature and extent of hazards depend. From these data general evaluations of potential solvent hazards can be made. The major portion of the book is devoted to a table in which the properties of 225 solvents are presented. While the handbook is principally concerned with the health hazard problems, it also includes fire and explosion data. *National Association of Mutual Casualty Companies.* L-62

Aliphatic Resin Base Glue. The characteristics of an aliphatic resin base glue, tradenamed Titebond, are described in a 36-page technical bulletin. It is divided into four sections: a description of testing devices and procedures; a data sheet in which physical properties are presented at length; a general information section, devoted in main to describing edge gluing and assembly gluing techniques, and a commercial applications section. An extensive use of graphs is made to portray data on viscosity, setting time, shear strength and other properties. A comprehensive presentation. *Franklin Glue Co.* L-63

Solid Plasticizers. The subject of a new 8-page bulletin is solid plasticizers. The physical properties and chemical characteristics of these products are enumerated and recommended uses are listed. These include application in delayed-tack adhesives, which are activated by heat, and once activated, remain tacky long enough to permit handling before the adhesive cools and sets. Other of the solid plasticizers are recommended for book-binding adhesives. *Monsanto Chemical Co.* L-64

Phenolic Resins. A new, 8-page illustrated brochure describes a complete line of phenolic resins, varnishes and molding powders. Text and charts are used to present the data, both descriptive and technical, on the various products. One of the phenolic resins is recommended for use in bonding shell mold halves together in shell-bonding equipment, and another, a powdered two-stage phenolic resin, for use in combination with nitrile rubber for brake-lining cements, or general industrial adhesives in bonding metal to rubber, metal to metal, and for other applications. *General Electric Co.* L-65

Gluing Equipment. A 6-page bulletin shows different machines used for the preparation and application of adhesives. These include glue spreaders, both floor and bench type, hand feed glue spreaders, cold glue mixers, electric glue pots and an apparatus for the preparation of hot glue. Each unit is illustrated with a photograph, and text is used to indicate sizes, design features, and other relevant information. Laminating and clamping equipment is also featured in the brochure. *Black Brothers Co., Inc.* L-66

Corrosion Proof Adhesive. Directions for mixing and a list of various applications are contained in a two-page technical bulletin on Amphesive 801. A complete listing is given of the materials to which this product bonds. Detailed charts give the corrosion resistance of the manufacturer's modified epoxy resin based products to various acids, alkalies, acid salts, gases, neutral salts, and organic materials. A simplified key system makes it possible to read the charts almost instantaneously. *Atlas Mineral Products Co.* L-67

Resin Pump. The design features of a pump which meters, mixes and dispenses two-part resins for various commercial applications are described and illustrated in a 4-page brochure. The operating principles involved are analyzed in text with a diagram, and the advantages of adaptability and economy of operation claimed for the pump are presented. *H. V. Hardman Co.* L-68

FOR MORE INFORMATION on the trade literature reviewed here, use the Reader's Service Card elsewhere in this issue.

CLASSIFIED ADVERTISING

Rates: All Classifications except Positions Wanted:

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Boxed, per inch or fraction.....$25.00

(approximately 60 words per inch)

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Set solid, no separate headings or boxes ..... $2.50 for 25 words or less; extra words, 10¢ each. Count 5 words for box number address.

Replies will be forwarded via ordinary mail without charge.

Note: Cash must accompany order.

POSITIONS WANTED

COMPOUNDING CHEMIST, age 36, B.S. Ch.E. 1950. Broad polymer background including epoxies and polyesters. Desires challenging position in adhesives field. Interested in development, technical service, or junior management. Address Box A-107-P, ADHESIVES AGE.

HELP WANTED

PACKAGING ADHESIVE CHEMIST

The Borden Chemical Co. needs a personable aggressive chemist or chemical engineer with experience in the compounding of vinyl acetate or latex adhesives for use on modern high speed packaging machinery. We need help in our most rapidly growing department to keep up with the demands of the expanding packaging industry. The location is in a rural upstate New York area where excellent outdoor recreational facilities are available away from the mad rush of city living. Write to: Dr. Robert B. Dean, Manager Sales Development Laboratory, BORDEN CHEMICAL COMPANY, A Division of the Borden Company, Bainbridge, New York.

BUSINESS OPPORTUNITIES

RESINS MARKET—FOR SALE

Plasticizer and Adhesive Markets are available to your sales force if you know where to go and what to offer. We can obtain these answers for your specific products. Market analyses and surveys are our primary business. CHEMICAL MARKETING & RESEARCH CO., 10 East 39th Street, New York 16, New York—MUrray Hill 5-8636.

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in passing

Technical Approach

► All of us have wondered at one time or another just where and when the spark of creative ingenuity is lighted. This applies to products and materials of all kinds—and adhesives are no exception. Accordingly, we were delighted with the following story which appeared in a recent issue of the house organ published by the Frederick S. Bacon Laboratories of Watertown, Massachusetts: "We were just sitting around wishing we were on a boat or a mountain or something; it was that hot and humid. I kept pulling my shirt off my back so the air from the fan could cool me off a little. This got me to wondering about adhesives and why would it be so hard to stick fabric to a smooth sheet of metal; sort of like a shirt sticking to your back. So I put some more plasticizer in our all-purpose adhesive so it would stay soupy and smeared some on a chrome sheet and slapped on a piece of broadcloth. You can't pull the fabric off without ripping it to shreds."

Selective Machine

► The Westinghouse Electric Corporation recently won an award from the American Association for the Advancement of Science for developing a machine with the ability to choose between right and wrong decisions. Known generally as an "optimizing control machine," or in the new concept of identifying things by letter groupings as OPCON, it is recognized as a new concept in the robot field. Actually, the unit is being used for various industrial purposes to run a complete distillation column at the Marcus Hook refinery of Sun Oil. We wish that the cost of this selective machine was in the range of the smaller adhesive manufacturer, who so frequently is faced with the problem of: Is this the right or the wrong adhesive to recommend?

Million-a-Minute

► It is very difficult for the average taxpayer to really understand the monumental funds expended by the Government. Just trying to visualize spending of the order of $80 billion or more a year is tremendously difficult. The Tax Foundation, which keeps a pretty close watch on government spending, has come up with a formula which will help some of us to a better understanding, namely: The 1958 session of Congress lasted 138 days, and the Congress spent money at the rate of $417,000 per minute, working 24 hours a day. That seems clear enough, but obviously nobody works 24 hours a day. Accordingly, commenting on this formula, the *Wall Street Journal* suggested another approach. If you figure the spending on the same eight-hour day most of the taxpayers put in to raise the money Congress spends, then in 1958 Congress spent the taxpayer's money at the rate of more than $1,253,000 a minute. Makes you stop and think, doesn't it?

Vinyl-Metal Laminates

► According to some information we have received, sales of vinyl-metal laminates as finish material for many products rose from 1,000,000 square feet in 1955 to something like 20,000,000 square feet in 1958, an increase of 2,000 per cent! Sales in the current year are expected to increase substantially over the 20,000,000 figure. Introduced only five years ago, vinyl-metal laminates have been booming because the pre-finish advantage of the material eliminates labor, space and equipment required for painting or spraying. They are now being used in such products as television and high fidelity cabinets, cameras, slide projectors, luggage, showcases, beverage dispensers, vending machines, casual furniture and numerous others. These vinyl-metal laminates represent a growing market for adhesives. More power to them!

Value of Standards

► For several years one of our Congressional committees has been needling the Defense Department on two objectives: (1) Set up a standard catalog, and (2) cut down on the variety of similar things bought by the different armed services. The first has been achieved, at a cost of $162 million, and the second is well on its way. The value of establishing standards is brought home sharply by some of the accomplishments to date. For example, 8 new thermostats now fit all military engines, compared to the 350 formerly on record; one standard rivet replaces four; 14 different kinds of heads for machine screws have been cut to 4; two types of waste baskets are provided for compared with 18; 16 kinds of erasers have replaced 98. These are typical of what has been accomplished, and there's more to come. Some of the savings, despite serious overtones, are amusing. Such as: 88 kinds of men's drawers have been eliminated; women's dress shoes have been reduced from 800 to 600 styles.